Pear Pest Management Alliance Project Final Report

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The statements and conclusions in this report are those of the contractor and not necessarily those of the California Department of Pesticide Regulation. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

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Executive Summary

The overall project focus is to establish and/or expand codling moth (CM) pheromone mating disruption (MD) projects in each of five pear growing counties: Lake, Mendocino, Solano, El Dorado and Sacramento. The primary goal of the project is to use pheromone mating disruption, a reduced risk pest management practice to reduce the use of organophosphate (OP) pesticides applied for the control of codling moth. Codling moth is the primary pest of pears and apples and if left uncontrolled can render the pear crop unmarketable. While pheromone mating disruption is not a stand-alone control tactic, it has allowed those growers who use the tactic to reduce the use of organophosphates by 70% or more and maintain economic control of codling moth. A research component of the project evaluates new insecticides for true bug. A decrease in OP usage has lead to an increase in damage from these secondary pests.

Additionally, a demonstration project in Yuba and Sutter Counties was conducted to show the biological fireblight control agent, Blight Ban A 506® could be effective at less than label rate yet allow for the reduction of antibiotic use by 50 - 60% and maintain fireblight control. Total amount of the grant is $100,000

In **Lake County** 820 acres were treated with codling moth pheromone using the Paramount Aerosol Dispenser®. These dispensers are similar to scent dispensers found in public bathrooms; although, their construction is much more robust because of the harsher elements found in the orchards. This method of pheromone dispensing requires relatively few dispensers per acre (1-2) and they are much less labor intensive than hanging individual twist-tye dispensers placed in each tree. Results in 2000 are encouraging; although, previous research has indicated that mating disruption of any type requires a multi-year, multi-tactic strategy. Orchards using pheromone for the first year require one to two OP applications while orchards in their fifth year of pheromone disruption may not apply any OPs or perhaps treat small portions of the orchard one time where trap catches indicate the need for treatments. Conversely, conventional orchards are sprayed for codling moths with OPs three to four times per season. (Note: The Lake County report includes work performed under DPR Contract # 99-0212.)

This was the fifth year of an implementation program in the **Mendocino County** aimed at facilitating and broadening the adoption of codling moth mating disruption. This year the acreage under the project (1030 acres) remained approximately the same as last years. Organophosphate use for codling moth control was reduced by 87% from the average of three OP cover sprays per year used from 1991 to 1995. There was an increase in codling moth populations in several blocks and a slight increase in leafroller damage. Boxelder bug damage was observed in the first 10 rows from the Russian River. This was the second year where the management of the project was under the Ukiah Valley IPM Pear Growers Coalition. Both the Lake County and Mendocino County projects received DPRs IPM Innovators Award.

The mating disruption practices used in the Pear Pest Management Alliance (PMA) Project in the **Sacramento River District** are based on methods developed during the

period 1993-98 in the Randall Island Project. The primary strategy in this district is to apply pheromone dispensers at the rate prescribed by the manufacturers shortly after the first codling moth (CM) biofix, in combination with reduced applications of organophosphate (OP) insecticides - usually a single application. The goal of the 1999-2000 Pear PMA project in this district was to aid and educate growers who had not yet used mating disruption (MD) in the transition to this program. The participating growers, new to mating disruption, were able to reduce their OP applications by 75% from their previous years conventionally farmed orchards.

Most pear orchards in **El Dorado County** are smaller than in other pear districts and the mountainous terrain makes for uneven application of pheromone. These factors make it more difficult for MD to be as successful as in other pear growing areas. In this project, three growers used Codling Moth mating disruption (MD). Two growers first used MD in 1999 and one grower began this season. (A third grower participated in 1999. That block was removed between seasons). In 1999, sprays were modestly reduced in the two participating blocks. The goal was to reduce them further in this second season. That goal was met as those blocks were treated one time each with an OP. The first year block had a very high codling moth (CM) population. This is because the fruit was not harvested nor sprayed in 1999 due to extensive hail damage. Thus, there was a high oveerwintering CM population. In 2000, MD combined with 3 OP sprays brought CM damage down to a level where the crop could be harvested and marked.

Most pear orchards in the Suisun district (**Solano County**) are smaller than in other pear districts. The district is known for windy conditions. (Suisun means "west wind" in the local indigenous tongue.) The trees are trained in a very open style and are widely spaced in the typical orchard. All of these factors make it more difficult for MD to be as successful as in other districts. In this project, five growers (seven total orchards) used CM mating disruption. Three of these growers had used MD for one season in 1994 but had abandoned it due to cost and poor crops in subsequent years. At that time, monitoring in MD blocks was less well refined and dispensers released inconsistent amounts pheromone. Three to four OP sprays per season is standard in non-MD orchards in this district. All participating blocks had OP sprays reduced relative to previous seasons without MD. In the MD blocks, three growers reduced spraying to two applications. One grower used three applications including a spray for Fruit Tree Leafroller prior to CM application timing. Three OP sprays were directed at CM in the remaining three orchards

The true bug research project was a two year project and we have incorporated both 1999 and 2000 findings into this final report. True bugs were not considered to be major pear pests in the past. However, recent changes in the codling moth (CM) management have resulted in increased damage by true bugs. True bugs are often controlled indirectly by OP insecticides that are applied for CM control. The pheromone mating disruption programs for CM has successfully suppressed CM, consequently, OP use was reduced by about 75%. Unfortunately, the reduced usage of OP insecticides resulted in a substantial increase in true bug. If outbreaks of true bugs occur in mating disrupted orchards and require OP or carbamate insecticide applications for their control, then the value of the IPM program that reduces OP insecticides use will be threatened. New true bug insecticides, which are effective,

environmentally benign, biologically selective and exhibit low mammalian toxicity must be found and registered in order to reap the ecological benefits of the pheromone based CM management strategy.

Fireblight disease, caused by the bacterium *Erwinia amylovora*, has been shown to be partially controlled by the biological control agent *Pseudomonas fluorescens* Strain A506, currently sold as BlightBan A506® by Plant Health Technologies, Inc. Research has also shown that A506 is capable of colonizing blossom tissue at lower than current label rates as long as conditions for colonization are favorable. More recently, it has been observed in small scale trials that colonization of partially opened flower buds (1-5% bloom stage) could be enhanced by combining the A506 with a silicon based surfactant by facilitating penetration deep into bud tissue. A506 could then colonize buds before they became occupied by competing bacteria. This would also theoretically allow the user to apply A506 earlier in the season and eliminate concerns about its compatibility with scab fungicides. Finally, enhanced early colonization could eliminate later sprays.

Pest Management Grants Final Report
Contract No. 99-0212
&
Contract No. 98-0333

Contract Title: *Areawide Implementation of Mating Disruption in Pears Using Puffers*

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DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Department of Pesticide Regulation. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

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ABSTRACT

Codling moth (*Cydia pomonella*) (CM) is the primary pest of pears in California. The economic threshold for cannery damage is 5% (including all other defects). FQPA and CalDPR use restrictions on azinphosmethyl and encapsulated methyl parathion have hastened the adoption of alternative CM control programs, mainly using mating disruption (MD). In 2000, 820 acres of pears in Kelseyville, Lake County were treated with the new Paramount Aerosol Pheromone Dispenser®, a method which entails hanging relatively few (1-2 per acre) widely-spaced units around the orchard perimeter, each emitting a large amount of pheromone for a finite period each day, and above a certain ambient temperature threshold. To monitor CM activity, one set of four traps was hung per five acres: 1 mg. low, 1 mg. high, 10 mg. high and oblique-banded leafroller (OBLR) (the major secondary pest of CM MD programs). Egg-laying and larval infestation was evaluated for each CM and OBLR generation using tree, ground, and bin samples. Puffer-treated orchards were compared to an upwind 20-acre standard treated block and two upwind untreated sites. Harvest data showed a total of less than 0.2% damage in the puffer treated blocks, with the majority of damage in first-year upwind and border blocks adjacent to less-effective MD methods and large open spaces. Slight damage also occurred adjacent to a riparian corridor. Damage in the grower control was 0.0% and 48% in the untreated controls. OBLR damage averaged 1.0% and was present in almost all blocks at harvest but least where chlorpyrifos (e.g. Lorsban®) was applied pre-bloom, followed by a BT treatment for the first summer generation hatch. Due to the success of the program, acreage in the Kelseyville puffer project has increased to 1360 acres in 2001 and the total Lake County acreage treated with puffers is nearly 2000. The project also received CalDPR's 2000 IPM Innovator Award, one of eight awards statewide.

EXECUTIVE SUMMARY

Codling moth (*Cydia pomonella*) (CM) is the primary insect pest of pears in California. The maximum threshold for cannery damage is 5% (including all other defects). Food Quality Protection Act (FQPA) and CalDPR use restrictions on azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (i.e. Penncap®) have necessitated the rapid transition to alternative CM control programs, mainly using mating disruption (MD). Resistance of CM to azinphosmethyl is another factor stimulating decreased dependence on that material.

CM MD has been studied in California since 1986. The main commercial strategy employed in California has been to hang 160-400 individual codlemone dispensers per acre twice during the growing season. This is a labor-intensive process during an era of tightening labor availability, increasing costs, and relatively decreasing returns. In addition, users in some locations have also experienced variable pheromone emission during very cool or hot weather, which has led to diminished disruption in some cases. The late Dr. Harry Shorey of UC Riverside developed a new emission strategy to resolve the above issues. His dispenser was designed to emit a very large, uniform amount of pheromone at preset intervals, thus eliminating emission variability. Only one hanging of one or two units per acre was necessary, greatly reducing labor cost. Dr. Shorey named the unit the "puffer", and upon his death in 1998, it was developed commercially by Paramount Farming Co. of Bakersfield, California, and was named the Paramount Aerosol Pheromone Dispenser® in 2000.

MD research using puffers on the North Coast began in 1996 in cooperation with Dr. Shorey. Initial trials, sponsored by the Pear Pest Management Research Fund, took place on 160 acres of Bartlett pears in Kelseyville, Lake County. In 1999, acreage expanded to 500 with funding from the USDA, and to 820 in 2000 under a CalDPR Demonstration Grant and the Pear Pest Management Alliance. (360 acres of pears in Potter Valley, Mendocino County, virtually the entire acreage in the valley, were also treated in 1999, the first year of CalDPR Demonstration Grant funding). Participants in 2000 included ten growers and five licensed pest control advisers (PCAs). Standard treated orchards in the area had historically high CM pressure, requiring from three to four organophosphate treatments most years. Dispensers were hung at a rate of 1.13 per acre, down from 1.3 in 1999 and 1.6 in 1996-1998. 42 mg. of codlemone was emitted every 15 minutes from 3:00 p.m. to 3:00 a.m. from April 1 through early October.

CM adult activity was monitored using four traps per five acres: 1 mg. low, 1 mg. high, 10 mg. high, and oblique-banded leafroller (OBLR) (the major secondary pest of CM MD programs). Egg laying and larval infestation was evaluated for each CM and OBLR generation using tree, ground, and bin samples during both the growing season and after harvest. Puffer-treated orchards were compared to three upwind sites: a 20-acre standard-treated block, and two sets of untreated trees. Although supplemental treatment decisions were made by growers and the PCA, all first year growers and those with CM damage in 1999 were advised to apply an initial OP and/or border sprays as needed.

Samples taken prior to, during, and after harvest showed virtually no CM damage in most puffer blocks, despite the fact that no OP's were applied during the growing season to orchards that had been in the program more than two years. Damage in the 37 puffer blocks was 0.15% at harvest and was restricted to first-year upwind blocks and border blocks adjacent to less effective MD methods and large open spaces. Slight damage also occurred adjacent to a riparian corridor. Damage in the standard grower control was 0.0%. Damage in untreated controls was nearly 48%, almost double that of 1999. OBLR damage averaged 1% and was present in nearly all

blocks at harvest, but was most severe in those blocks lacking pre-bloom chlorphyrifros (Lorsban®) applications. BT applications successfully reduced the amount of damage by the summer brood, indicating potential for this tactic. A mixed CM/OBLR puffer unit was evaluated during the 2000 season in two of the project blocks; while trap catches were reduced 90%, damage was not significantly reduced.

Total material and monitoring costs using puffers was tabulated in 1999. For an individual orchard of 40 acres or less, material costs using two dispensers per acre are $240/acre initially, plus $350 for a programming unit and negligible labor costs. This decreases to $160/acre thereafter. The number of units per acre decreases as treated acreage increases, offering substantial savings when applied on an areawide basis. CM MD is currently more expensive to monitor than a standard organophosphate program. Much of the additional monitoring costs have been underwritten by various grant funds, but must be eventually be borne by growers. A less intensive trapping rate is being utilized in 2001 as confidence in the MD technique has increased. Monthly pesticide use report data is also being collated to show that reduced pear psylla and spider mite treatments offset many of the added costs after the first year. This is corroborated by the fact that the only blocks which required a post-harvest mite and/or psylla treatment in 2000 were those which received in-season OP sprays. Fifth year puffer orchards received one or no in-season mite or psylla sprays.

Progress and results of the 2000 Kelseyville project season were presented in both English and Spanish at summer field days in Lake and Mendocino Counties and at several winter grower meetings in Lake, Sacramento, and El Dorado Counties. Despite very poor returns for pears in 1999 and 2000, nine new growers committed to purchase the puffers for the 2001 project season. Results from the USDA/CalDPR project have led to increased puffer use in other areas of Lake County and in Mendocino County, as well as renewed interest in the technique in walnuts and pears in other areas of California. Total puffer treated acreage is now about 2500 on the North Coast, or about 30% of the acreage. If results continue to be positive in 2001, it is likely that more North Coast pear growers will seriously consider purchasing puffers for future use.

INTRODUCTION

Codling moth (*Cydia pomonella*) is the key pest of pears in California. The economic threshold for damage in cannery loads is 5% (including all other defects). Damage in untreated controls ranges from 10 to 50%, signifying great need for effective control. State and federal actions in 1998 and 1999 have resulted in the restriction or loss of the two key organophosphate insecticides used to control codling moth, azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (e.g. Penncap®). These restrictions have necessitated rapid transition of the pear industry into alternative pest management programs. The most proven and available current alternative is mating disruption, which has been researched in pears since 1987. Mating disruption has been demonstrated to be most effective when utilized on an areawide basis in orchards under low to moderate codling moth pressure. The most widely used strategy is hanging 150-400 pheromone dispensers per acre throughout a treated block. Each dispenser emits a small amount of pheromone over the life of the unit, about 60-120 days.

The 2000 demonstration project utilized an alternative, reasonably priced dispenser, the "puffer", developed by the late Dr. Harry Shorey of UC Riverside. The puffer has been further developed and registered by Paramount Farming Co., a large almond and pistachio operation in Bakersfield. It is manufactured in Canada and sold directly by the new subsidiary Paramount Ag Technologies, Inc. The codling moth product is now registered as the Paramount Aerosol Codling Moth Pheromone Dispenser®. Rather than hanging many dispensers that each emit small amounts of pheromone, this method involves hanging two or fewer dispensers per acre, each emitting a large amount of pheromone at preset intervals and above a minimum ambient temperature threshold for 200 days. This dispenser was the focus of three years of pear industry-funded UC research on 160 acres in Lake County, which expanded to 500 acres in 1999 under a USDA Areawide Codling Moth Project (CAMP) grant then 820 in 2000 under the current sponsorship of California Dept. of Pesticide Regulation through the Pest Management Demonstration Grant and Pear Pest Management Alliance programs.

The success of the Lake County project led to an additional areawide puffer project in 1999 to control codling moth on 360 acres of Bartlett and Bosc pears in Potter Valley, Mendocino County. This was nearly the total acreage in the valley and included 75 acres of certified organic fruit. Only one 22-acre block of Bartletts and one 2-acre block of organic pears remained untreated which were used as "grower controls". One set of untreated apple trees upwind of the project area served as a completely untreated control. Results were excellent in non-organic blocks, which received no OP treatments for the entire season. The organic blocks remained problematic due to extreme initial pressure and inability to adequately supplement MD. Due to very poor market conditions, however, the Potter Valley project was disbanded in 2000 as the growers could not commit to purchasing puffer units.

The expanded Lake County project, however, continued to demonstrate the four primary objectives in 2000:

1) Demonstrate a cost-effective, labor saving, efficient, commercially available method of delivering pheromone in a mating disruption program.
2) Verify the minimum level of monitoring needed to commercially use this method.
3) Produce commercial yields of U.S. #1 Bartlett and Bosc pears using greatly reduced amounts of organophosphate insecticides.
4) Control secondary pests as needed.

RESULTS

a) ***Objective 1:*** *Demonstrate a cost-effective, labor saving, efficient, commercially-available method of delivering pheromone in a mating disruption program.* CM damage to puffer-treated blocks at harvest was 0.15% overall across 37 blocks versus 0.0% in the one standard control block and nearly 48% in the untreated controls in 2000. Damage occurred only in first-year upwind blocks with large edge effects i.e. where the orchard bordered less effective mating disruption, or large open areas, or in proximity to apple trees. More telling, damage averaged 0.32% in first year blocks, located on the south and west upwind borders, but only 0.03% in second year blocks and 0.0% in the five original project blocks treated since 1996. Post-harvest damage, which indicates potential overwintering flight and damage potential the following season was 0.4% and only occurred where bin damage was found (a first cover OP will be recommended in these blocks in 2001). Like CM, OBLR damage was most severe in first year blocks, but present throughout all puffer-treated blocks, while the OP-treated grower control was free of damage. The puffer units lasted the entire season, showing only one hanging per season is required, although there was one (unexpected) battery change (Tables 1 to 6).

b) ***Objective 2:*** *Verify the minimum level of monitoring needed to commercially use this method.* Only one moth was caught in 1 mg. low traps in puffer blocks through the entire season, versus almost 50 in the much smaller untreated controls. 1 mg. high traps caught 40 moths (0.05 per acre), but also caught moths in some blocks that had no 1 mg. low catches. 10 mg. high traps caught the most moths in the puffer blocks. The best correlation with damage in 2000 was with 1 mg. high traps, which correctly predicted damage in 71% of the blocks where it occurred, and likewise correctly predicted no damage would occur in 86% of damage-free blocks. 10x high traps correctly predicted damage 50% of the time it occurred but were 83% correct in predicting no damage. OBLR traps caught many moths, but numbers showed no statistical correlation to severity of damage. The 5-acre trapping unit, though intensive, resulted in being able to pinpoint potential "hotspots". In 2001, the number of trap sets monitored by UCCE staff will be reduced to verify if fewer traps can be used to predict damage. A cut fruit sampling technique developed by Dr. Broc Zoller to monitor egg laying will also be tested (Table 7).

c) **Objective 3:** *Produce commercial yields of U.S. #1 Bartlett and Bosc pears using greatly reduced amounts of organophosphate insecticides.* No OP was applied to multiple year blocks during the 2000 season, versus the standard block that received at least two sprays. First year blocks received one to three OP treatments depending on trap catches and egg sampling. Exact amounts applied are currently being compiled from monthly use reports.

d) ***Objective 4:*** *Control secondary pests as needed.* No attempt was made to dictate secondary pest control. Leafrollers were controlled by one pre-bloom chlorpyrifos (e.g. Lorsban®) and perhaps one or two BT sprays for the first summer hatch. OBLR damage averaged 1.0% at harvest and ranged from 0.0-9.2%. Damage was worst where no pre-bloom Lorsban® was applied, and near riparian corridors. Only one in-season pear psylla and mite treatment was applied in most puffer-treated orchards, using much lower rates than needed in OP-treated blocks. Post-harvest treatments were also unnecessary in puffer-treated orchards. In fact, fifth year orchards required no in-season or postharvest mite or psylla treatments. Data on secondary pest treatment is still being compiled from monthly use reports. Very little stink bug damage was noted at harvest (0.013%) and no San Jose scale was found.

DISCUSSION

Data at harvest indicated several points:

1) Mating disruption, specifically the Paramount Aerosol Codling Moth Pheromone Dispenser®, controls codling moth well even in a first year program *if* orchards start the season with relatively low pressure, and particularly when supplemented by at least one well-timed, effective cover spray.

2) Orchards that begin the season with high pressure will require greater supplementation by insecticides and more years to achieve adequate control. In 2000, the most problematic orchards were those on upwind edges bordered by less effective pheromone programs or large areas of open space or vineyard. Damage was also found close to backyard apple trees and in one orchard that had previously contained an untreated control in one corner. Insecticide applications, however, may only be necessary on borders as transectional sampling indicated damage, declined from 5-10 rows into the block in several instances.

3) Leafrollers, specifically oblique-banded leafroller (OBLR), will need to be controlled with chemicals under CM mating disruption because OBLR pheromone is still inadequate. Orchards lacking pre-bloom Lorsban® had the most OBLR damage. BT applied for the first generation hatch was quite effective in reducing the severity of OBLR damage, and could be useful in mating disruption programs provided weather conditions are conducive to excellent timing and coverage. Other secondary pests, such as stink bugs and San Jose scale, may also eventually be problematic but only early-season damage from Western flower thrips was noticeable in 2000.

As a mating disruption tool, puffers are good dispensers in that distribution pattern, emission rates and timing are controllable and flexible, and they are only slightly affected by changes in ambient temperature (due to vapor pressure shifts). However, experience in 2000 brought out several economic and logistical issues:

a. Units must be periodically taken down and checked to make sure they are emitting correctly. They are susceptible to being knocked down by heavy wind and human activity, such as spraying and harvesting. In 2000, batteries unexpectedly needed to be changed about two-thirds through the season. Checking each unit takes about one minute per unit and can be done at the same time traps are checked. Another two or three minutes is required if reprogramming is required. UCCE staff recommended that 20% of the units be taken down and checked every two weeks in 2001.

b. The accompanying programming unit currently costs $350.00 and must be purchased separately by the user(s). It is very important that users are well trained in its function to avoid possible misprogramming.

c. The current initial cost to enter the puffer program is theoretically an impediment to adoption, especially in poor market years such as 2000 (though few growers have thus far been deterred). For example, at the maximum two per acre for one 40-acre block, the cost would be $40.00 per unit x 2 = $80.00 plus $80.00 per filled cannister x 2 = $160.00, for a total cost of $240.00 per acre. Cost to hang, check and remove adds about $3.00 per acre. This is compared to $220.00 for two hangings of 400 Pacific BioControl dispensers plus about $25.00 per acre per hanging for application, or about $270.00 per acre per season. Once the puffer and programming units are purchased, they are guaranteed for at least five

years, so annual cost for a 40-acre or less block is reduced to $160.00 per year plus hanging, checking and removing. As acreage increases, the number of units per acre decreases, making the system most cost effective for areawide programs where growers share up front and ongoing program expenses and benefit from reduced per acre costs. In 2000, the 820 acre project in Kelseyville used 1.13 units per acre. Also, as the total number of units purchased increases, the manufacturer will theoretically be able to purchase pheromone at a cheaper price, thus reducing the cost of a filled cannister.

SUMMARY AND CONCLUSIONS

The UC Shorey "puffer", now sold as the Paramount Aerosol Pheromone Dispenser®, was utilized to control codling moth in an areawide demonstration project in Kelseyville, Lake County. The project was an expansion of an industry-funded one initiated by Dr. Harry Shorey and the current Principal Investigator in 1996. The original 163 acres are now entering their sixth year. An additional 337 acres were added in 1999, which expanded to 820 acres in 2000.

Acreage added in 2000 was almost all on the upwind south and west edges, and along a bordering riparian corridor. It was expected these blocks would require supplemental OP treatments to reduce the incoming population and mitigate certain "edge effects".

Puffers were hung at an average rate of 1.13 per acre (0.2 per acre fewer than in 1999), mainly around the perimeter of each block. Both codling moth and leafroller populations and damage were monitored throughout the growing season. Trap catch, egg-laying, and damage data showed that:

1) Codling moth pressure was much higher in 2000 than in 1998 or 1999, with higher overall trap catches and damage in all growing areas. Despite this, damage in the 37 puffer-treated project blocks was only 0.15%.
2) Virtually all damage occurred in first year, upwind blocks and mainly in rows bordered by either a) large open space or vineyard, b) less effective mating disruption programs, or c) in close proximity to backyard apple trees. Damage also occurred in proximity to a previously untreated control that had built up a high population, and along bordering riparian corridors.
3) Damage was reduced ten-fold in second year orchards and was zero in fifth year orchards, despite a complete lack of OP sprays for several years.
4) OBLR damage continues to be a noticeable secondary pest. Damage was worst, however, in first year orchards and those lacking a pre-bloom chlorpyrifos application. BT applied for the first summer generation hatch reduced final damage.
5) Other secondary pests such as stink bugs and San Jose scale were unproblematic and have failed to thus far increase appreciably. Early-season thrips damage was noticeable, though not economic. Pear psylla and spider mite damage was minimal in puffer-treated blocks despite the omission of the pre-harvest treatment required to control mites in standard-treated orchards.
6) Trap catch data indicated that 1XH catch gave the best correlation with the presence or absence of damage. 1XL catches were minimal except in the untreated controls and one high-pressure puffer block. Presence of 10XH catches predicted damage in only half of the blocks where damage occurred, versus 70% for the 1XH traps. This contrasts with 1999 data in Potter Valley, Mendocino County, where damage was most closely correlated to 1XL catches.

Results after 2000 continued to be encouraging. As previous research and other demonstration projects have shown, however, mating disruption of any type is a multiple-year, multi-tactic strategy. In the Lake County project, one orchard required three years to reduce damage to zero and it is likely those with damage this year will need to receive at least one OP for the next one or two years. Growers must thus make a long-term commitment to the program, which often includes high initial costs required to reduce flight and subsequent damage. A plan to eliminate pressure from unfarmed apple and pear trees, especially upwind is becoming increasingly critical as mated females can fly 100 or more yards from an infested tree.

APPENDIX I

List of Figures and Tables

Figure 1

2000 Puffer Location Map

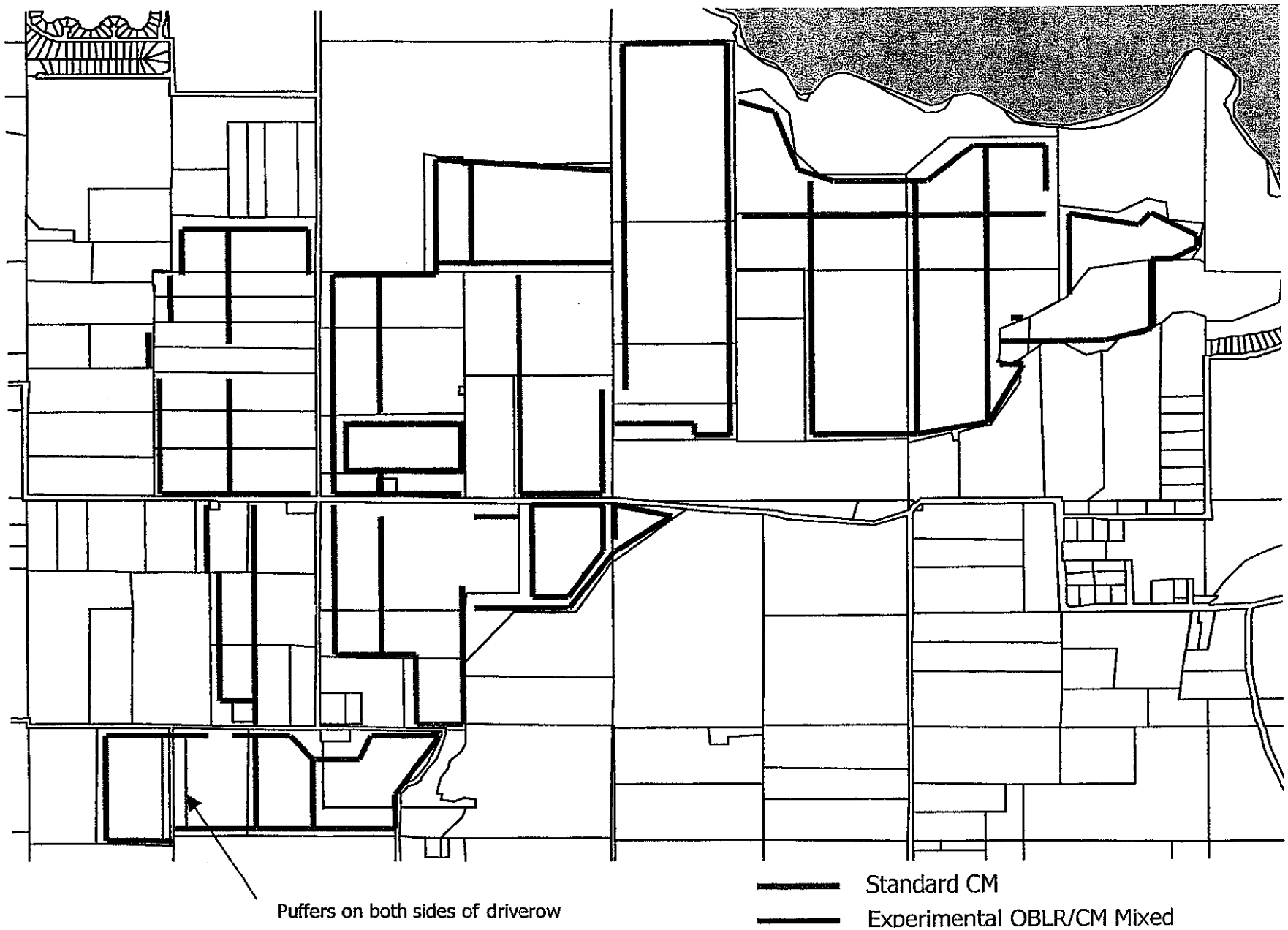
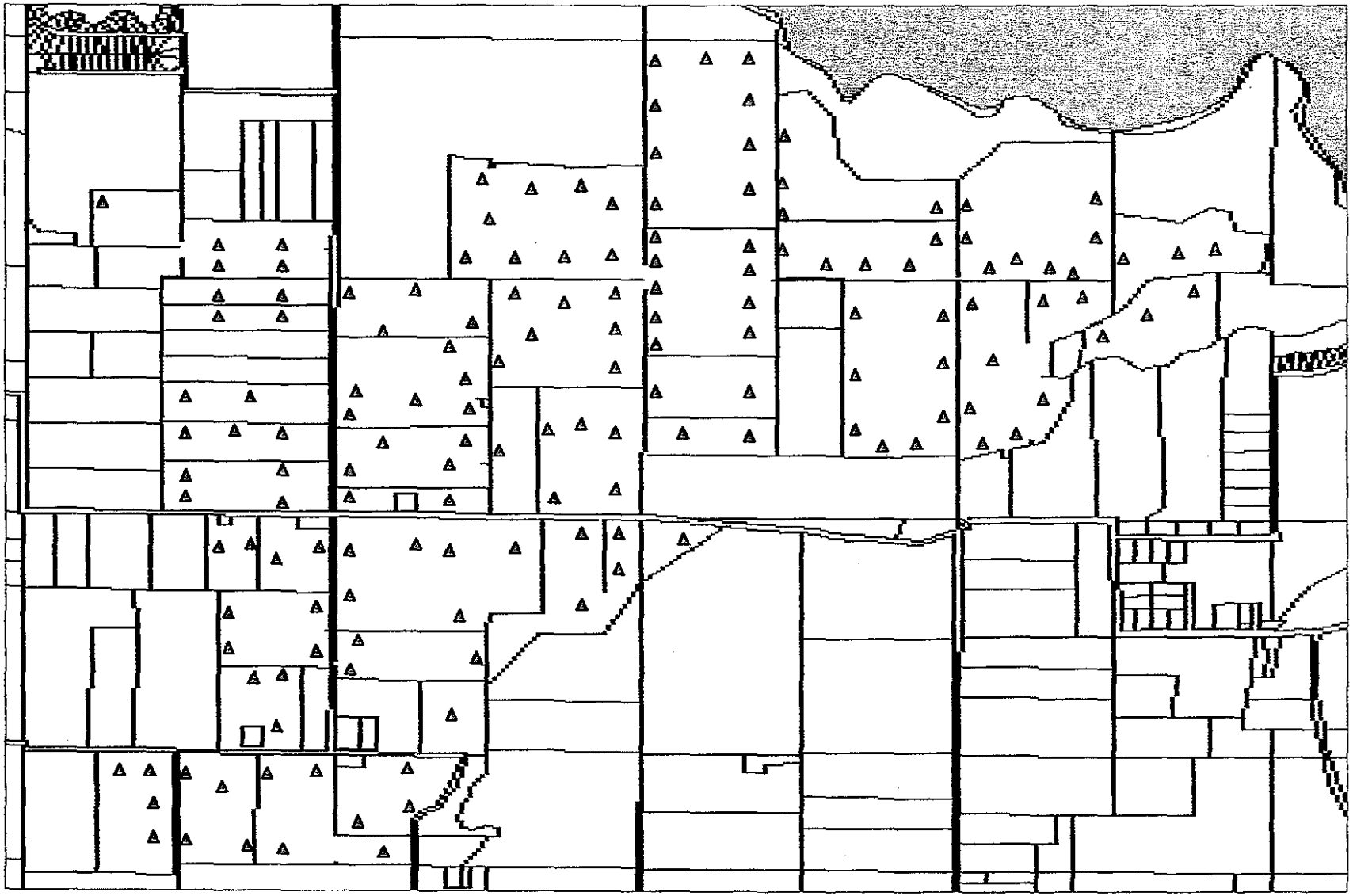


Figure 2

Trap set locations



2000 LAKE COUNTY PUFFER PROJECT
Codling Moth Trap Catches and Fruit Damage - Summary Table
April - September 2000
Ground Fruit Samples - %/500, Pre-harvest Tree Fruit Samples - %/2000
Table 1. Bin Fruit Samples - %/1000 and Post-harvest Samples - %/300

TREATMENT/BLOCK	Trap Totals 1XL	1XH	10XH	% 1ST GEN GRND DAMAGE	% PRE-HARV DAMAGE	% BIN DAMAGE	% POST-HARV DAMAGE
PUFFER							
North-west Area							
Hedgerow	0	0	0	0.0	0.0	0.0	0.0
Renfro	0	0	4	***	0.0	0.1	0.3
Pardee-Lake	0	0	4	0.2	0.0	0.2	0.0
Morrison	0	0	2	***	0.0	0.0	0.0
Akins	0	0	1	0.0	0.05	0.0	0.0
Pardee-home	0	2	7	0.7	0.15	0.1	0.0
South-west Area							
Colwell	0	7	5	17.0	1.6	1.2	1.0
Y/Stage	1	6	8	0.6	0.6	**	1.0
M/Twenty	0	6	7	0.0	2.7	0.3	5.0
E.A.T. Rickabaugh	0	1	2	0.4	0.0	0.0	***
Rohner Home	0	2	3	0.7	0.0	0.1	0.0
Old Rickabaugh	0	1	6	0.0	0.0	0.2	0.0
Lone Pine - 2 sections	0	1	0	0.0	0.0		3.0
East Neck	-	-	-	-	-	1.3	-
Main block	-	-	-	-	-	0.4	-
M/Brown	0	0	0	***	2.9	0.7	0.3
Murphy	0	11	12	17.3	3.3	0.9	2.0
Mid Area							
S/Stage	0	0	0	***	0.0	0.0	0.0
30 Acres	0	0	1	***	0.0	0.0	0.0
S/Timothy (sprayed)	0	0	2	***	0.0	0.0	0.0
S/Timothy (unsprayed)	-	-	-	***	0.05	0.0	***
M/Timothy	0	0	2	***	0.05	0.0	0.3
K-48	0	0	0	***	0.0	0.0	0.0
Cole	0	1	0	0.0	0.0	0.0	0.0
Sanderson	0	0	0	***	0.0	0.0	0.0
Cookson	0	1	4	***	0.0	0.0	0.0
Eutenier (sprayed)	0	0	0	***	0.0	0.0	0.0
Eutenier (unsprayed)	-	-	-	***	0.1	0.0	***
R/Brown	0	0	0	***	0.0	0.1	0.0
East Area Downwind							
Young West	0	0	0	0.0	0.0	0.0	0.0
Sixty	0	0	0	***	0.0	0.0	0.0
Fourteen	0	0	0	***	0.0	0.0	0.0
Trailers	0	0	0	***	0.0	0.0	0.0
Triangle	0	0	1	0.0	0.0	0.0	0.0
Young East	0	0	0	0.0	***	0.0	0.0
Quercus 20	0	0	0	***	0.0	0.0	0.0
Wide	0	0	0	***	0.0	0.0	0.0
Neck	0	0	0	0.0	0.0	0.0	0.0
Gaddy	0	0	1	0.0	0.0	0.0	0.0
BP Gaddy	0	1	0	0.0	0.0	0.0	0.0
Manning	0	0	2	0.0	0.0	0.0	0.7
AVERAGE PUFFER	-	-	-	1.8	0.3	0.15	0.4
GROWER CONTROL							
Springer	0	0	1	0.0	0.0	0.0	0.0
Quercus/Seven Acres[2]	-	-	-	-	-	0.2	-
AVERAGE GROWER CONTROL	-	-	-	0.0	0.0	0.1	0.0
UNTREATED CONTROL							
Quercus/Seven Acres	2	11	0	50.4	21.4	24.7	6.0 ***
Gold Dust	42	39	0	***	63.2	71.0[1]	86.0
AVERAGE UNTREATED	-	-	-	50.4	42.3	47.9	46.0

[1] not a bin count
[2] this area sampled only for bin damage.
** bin sample not reliable (pears were presorted before project team could sample).
*** most infested fruit had fallen already.

Table 2:

2000 LAKE COUNTY PUFFER PROJECT

1st Generation CM and OBLR Damage

Tree Fruit Samples - %/1000, Ground Fruit Samples - %/500

TREATMENT	Tree June 27-28, 2000			Ground July 18-25, 2000		
	CM 998 °D		OBLR 897 °D	CM 1314 - 1443 °D		OBLR 1335 - 1511 °D
	Eggs	Damage	Damage	Eggs	Damage	Damage
Average Puffer[1]	**0.06**	**0.04**	**0.26**	**0.1** [3]	**1.8** [3]	**1.6** [3]
Grower Control[2]	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Untreated Controls						
Quercus Seven Acres	3.3	3.8	1.0	8.4	50.4	0.8
Gold Dust (500 fruit)	0.6	27.8	1.6	**	**	**
Average Untreated Control	**2.0**	**27.8**	**1.3**	**8.4**	**50.4**	**0.8**

[1] 37 orchards

[2] 1 plot

[3] 21 orchards

** no ground fruit

2000 LAKE COUNTY PUFFER PROJECT

Late 1st and 2nd Generation Codling Moth Damage

Table 3a:

August 2 - 8, 2000, 1607 – 1722 °D

Pre-harvest Tree Fruit Sample - %/2000

TREATMENT/BLOCK	TOP	BOTTOM	TOTAL
PUFFER			
North-west Area			
Hedgerow	0.0	0.0	**0.0**
Renfro	0.0	0.0	**0.0**
Pardee-Lake	0.0	0.0	**0.0**
Morrison	0.0	0.0	**0.0**
Akins	0.1	0.0	**0.05**
Pardee-home	0.2	0.1	**0.15**
South-west Area			
Colwell	1.9	1.2	**1.55**
Y/Stage	1.1	0.1	**0.6**
M/Twenty	1.9	3.5	**2.7**
E.A.T.	0.0	0.0	**0.0**
Rohner Home	0.0	0.0	**0.0**
Old Rickabaugh	0.0	0.0	**0.0**
Lone Pine	0.0	0.0	**0.0**
M/Brown	3.3	2.4	**2.85**
Murphy	3.6	2.9	**3.25**
Mid Area			
S/Stage	0.0	0.0	**0.0**
30 Acres	0.0	0.0	**0.0**
S/Timothy	0.0	0.0	**0.0**
M/Timothy	0.1	0.0	**0.05**
K-48	0.0	0.0	**0.0**
Cole	0.0	0.0	**0.0**
Sanderson	0.0	0.0	**0.0**
Cookson	0.0	0.0	**0.0**
Eutenier (%/1000)	0.0	0.0	**0.0**
R/Brown	0.0	0.0	**0.0**
East Area Downwind			
Young West	0.0	0.0	**0.0**
Sixty	0.0	0.0	**0.0**
Fourteen	0.0	0.0	**0.0**
Trailers	0.0	0.0	**0.0**
Triangle (%/1000)	0.0	0.0	**0.0**
Young East	**	**	**
Quercus 20	0.0	0.0	**0.0**
Wide	0.0	0.0	**0.0**
Neck	0.0	0.0	**0.0**
Gaddy	0.0	0.0	**0.0**
BP Gaddy	0.0	0.0	**0.0**
Manning	0.0	0.0	**0.0**
AVERAGE PUFFER	0.3	0.3	0.3
GROWER CONTROL			
Springer	0.0	0.0	**0.0**
UNTREATED CONTROL			
Quercus/Seven Acres (%/1000)	33.6	9.2	**21.4**
Gold Dust (%/1000)	-	-	**63.2**
AVERAGE UNTREATED	33.6	9.2	42.3

** no sample

2000 LAKE COUNTY PUFFER PROJECT
Late 1st and 2nd Generation Codling Moth Damage
August 2 - 8, 2000, 1607 - 1722 °D
Table 3b: **Pre-harvest Tree Fruit Sample - %/2000**

PROJECT YEAR/BLOCK	TOP	BOTTOM	TOTAL
FIRST YEAR ORCHARDS			
Colwell	1.9	1.2	**1.55**
Y/Stage	1.1	0.1	**0.6**
M/Twenty	1.9	3.5	**2.7**
E.A.T.	0.0	0.0	**0.0**
Rohner Home	0.0	0.0	**0.0**
Old Rickabaugh	0.0	0.0	**0.0**
Lone Pine	0.0	0.0	**0.0**
M/Brown	3.3	2.4	**2.85**
Murphy	3.6	2.9	**3.25**
Young East	**	**	**
Quercus 20	0.0	0.0	**0.0**
Wide	0.0	0.0	**0.0**
Neck	0.0	0.0	**0.0**
Gaddy	0.0	0.0	**0.0**
BP Gaddy	0.0	0.0	**0.0**
Manning	0.0	0.0	**0.0**
AVERAGE FIRST YEAR	**0.79**	**0.67**	**0.73**
SECOND YEAR ORCHARDS			
Hedgerow	0.0	0.0	**0.0**
Renfro	0.0	0.0	**0.0**
Pardee-Lake	0.0	0.0	**0.0**
Morrison	0.0	0.0	**0.0**
Akins	0.1	0.0	**0.05**
Pardee-home	0.2	0.1	**0.15**
S/Stage	0.0	0.0	**0.0**
30 Acres	0.0	0.0	**0.0**
K-48	0.0	0.0	**0.0**
Cole	0.0	0.0	**0.0**
R/Brown	0.0	0.0	**0.0**
Young West	0.0	0.0	**0.0**
Sixty	0.0	0.0	**0.0**
Fourteen	0.0	0.0	**0.0**
Trailers	0.0	0.0	**0.0**
Triangle (%/1000)	0.0	0.0	**0.0**
AVERAGE SECOND YEAR	**0.019**	**0.006**	**0.013**
FIFTH YEAR ORCHARDS			
S/Timothy	0.0	0.0	**0.0**
M/Timothy	0.1	0.0	**0.05**
Sanderson	0.0	0.0	**0.0**
Cookson	0.0	0.0	**0.0**
Eutenier (%/1000)	0.0	0.0	**0.0**
AVERAGE FIFTH YEAR	**0.020**	**0.000**	**0.010**

** no sample

2000 LAKE COUNTY PUFFER PROJECT

Oblique-Banded Leafroller Damage

August 2-8, 2000, 1727 - 1881 °D

Table 4a: **Pre-harvest Tree Fruit Sample - %/2000**

TREATMENT/BLOCK	TOP	BOTTOM	TOTAL
PUFFER			
North-west Area			
Hedgerow	0.0	0.2	**0.1**
Renfro	0.3	0.9	**0.6**
Pardee-Lake	0.0	0.0	**0.0**
Morrison	1.0	0.5	**0.8**
Akins	1.1	0.2	**0.70**
Pardee-home	0.6	0.0	**0.3**
South-west Area			
Colwell	0.2	0.0	**0.1**
Y/Stage	0.0	0.0	**0.0**
M/Twenty	0.7	1.0	**0.85**
E.A.T.	0.0	0.2	**0.1**
Rohner Home	0.0	0.0	**0.0**
Old Rickabaugh	0.0	0.0	**0.0**
Lone Pine	0.0	0.0	**0.0**
M/Brown	0.5	0.0	**0.25**
Murphy	0.3	0.6	**0.5**
Mid Area			
S/Stage	0.2	0.1	**0.15**
30 Acres	0.2	0.0	**0.1**
S/Timothy	0.0	0.0	**0.0**
M/Timothy	0.3	0.4	**0.35**
K-48	0.0	0.0	**0.0**
Cole	0.0	0.0	**0.0**
Sanderson	0.0	0.0	**0.0**
Cookson	0.2	0.1	**0.15**
Eutenier (%/1000)	0.6	0.4	**0.5**
R/Brown	0.2	0.6	**0.4**
East Area Downwind			
Young West	0.2	0.6	**0.4**
Sixty	0.0	0.0	**0.0**
Fourteen	0.0	0.0	**0.0**
Trailers	0.0	0.0	**0.0**
Triangle (%/1000)	0.0	0.0	**0.0**
Young East	**	**	**
Quercus 20	0.0	0.0	**0.0**
Wide	0.0	0.0	**0.0**
Neck	0.0	0.1	**0.05**
Gaddy	0.0	0.0	**0.0**
BP Gaddy	0.0	0.0	**0.0**
Manning	0.0	0.0	**0.0**
AVERAGE PUFFER	0.2	0.2	0.2
GROWER CONTROL			
Springer	0.0	0.0	**0.0**
UNTREATED CONTROL			
Quercus/Seven Acres (%/1000)	0.0	0.8	**0.4**
Gold Dust (%/1000)	-	-	**1.4**
AVERAGE UNTREATED	0.0	0.8	0.9

** no sample

2000 LAKE COUNTY PUFFER PROJECT
Oblique-banded Leafroller Damage
August 2-8, 2000, 1727 – 1881 °D
Pre-harvest Tree Fruit Sample - %/2000

Table 4b:

PROJECT YEAR/BLOCK	TOP	BOTTOM	TOTAL
FIRST YEAR ORCHARDS			
Colwell	0.2	0.0	**0.1**
Y/Stage	0.0	0.0	**0.0**
M/Twenty	0.7	1.0	**0.85**
E.A.T.	0.0	0.2	**0.1**
Rohner Home	0.0	0.0	**0.0**
Old Rickabaugh	0.0	0.0	**0.0**
Lone Pine	0.0	0.0	**0.0**
M/Brown	0.5	0.0	**0.25**
Murphy	0.3	0.6	**0.5**
Young East	**	**	**
Quercus 20	*0.0*	*0.0*	***0.0***
Wide	0.0	0.0	**0.0**
Neck	0.0	0.1	**0.05**
Gaddy	0.0	0.0	**0.0**
BP Gaddy	0.0	0.0	**0.0**
Manning	0.0	0.0	**0.0**
AVERAGE FIRST YEAR	**0.11**	**0.13**	**0.12**
SECOND YEAR ORCHARDS			
Hedgerow	0.0	0.2	**0.1**
Renfro	0.3	0.9	**0.6**
Pardee-Lake	0.0	0.0	**0.0**
Morrison	1.0	0.5	**0.8**
Akins	1.1	0.2	**0.7**
Pardee-home	0.6	0.0	**0.3**
S/Stage	0.2	0.1	**0.15**
30 Acres	0.2	0.0	**0.1**
K-48	0.0	0.0	**0.0**
Cole	0.0	0.0	**0.0**
R/Brown	0.2	0.6	**0.4**
Young West	0.2	0.6	**0.4**
Sixty	0.0	0.0	**0.0**
Fourteen	0.0	0.0	**0.0**
Trailers	0.0	0.0	**0.0**
Triangle (%/1000)	0.0	0.0	**0.0**
AVERAGE SECOND YEAR	**0.24**	**0.19**	**0.22**
FIFTH YEAR ORCHARDS			
S/Timothy	0.0	0.0	**0.0**
M/Timothy	0.3	0.4	**0.35**
Sanderson	0.0	0.0	**0.0**
Cookson	0.2	0.1	***0.15***
Eutenier (%/1000)	0.6	0.4	**0.5**
AVERAGE FIFTH YEAR	**0.22**	**0.18**	**0.20**

2000 LAKE COUNTY PUFFER PROJECT
Codling Moth Damage
August 7 - September 1, 2000, 1703 - 2110 °D

Table 5a: **Bin Fruit Samples - %/1000**

TREATMENT/BLOCK	1st pick	2nd pick	TOTAL
PUFFER			
North-west Area			
Hedgerow	0.0	-	0.0
Renfro	0.1	-	0.1
Pardee-Lake	0.2	-	0.2
Morrison	0.0	-	0.0
Akins	0.0	-	0.0
Pardee-home	0.1	-	0.1
South-west Area		-	
Colwell	1.2	-	1.2
Y/Stage	**	-	**
M/Twenty (%/1200)	0.3	-	0.3
E.A.T.	0.0	-	0.0
Rohner Home	0.1	-	0.1
Old Rickabaugh	0.2	-	0.2
Lone Pine - 2 sections			
East Neck	1.3	-	1.3
Main block	0.4	-	0.4
M/Brown	0.7	-	0.7
Murphy (%/2000)	0.9	-	0.9
Mid Area		-	
S/Stage (%/2000)	0.0	-	0.0
30 Acres	0.0	-	0.0
S/Timothy (%/1200)	0.0	-	0.0
M/Timothy (%/1200)	0.0	-	0.0
K-48	0.0	-	0.0
Cole	0.0	-	0.0
Sanderson	0.0	-	0.0
Cookson	0.0	-	0.0
Eutenier (%/1200)	0.0	-	0.0
R/Brown	0.1	-	0.1
East Area Downwind		-	
Young West	0.0	-	0.0
Sixty	0.0	-	0.0
Fourteen	0.0	-	0.0
Trailers	0.0	-	0.0
Triangle	0.0	-	0.0
Young East	0.0	-	0.0
Quercus 20	0.0	-	0.0
Wide (%/2000)	0.0	0.0	0.0
Neck (%/2000)	0.0	0.0	0.0
Gaddy	0.0	-	0.0
BP Gaddy	0.0	-	0.0
Manning	0.0	-	0.0
AVERAGE PUFFER	0.15	0.0	0.15
GROWER CONTROL			
Springer (%/1200)	0.0	-	0.0
Quercus/Seven Acres	0.2	-	0.2
AVERAGE GROWER CONTROL	0.1		0.1
UNTREATED CONTROL			
Quercus/Seven Acres	24.7	-	24.7
Gold Dust1 (%/400)	71.0	-	71.0
AVERAGE UNTREATED	47.9		47.9

2000 LAKE COUNTY PUFFER PROJECT

Codling Moth Damage

Table 5b: **August 7 -September 1, 2000, 1703 - 2111 °D**

Bin Fruit Samples - %/1000

PROJECT YEAR/BLOCK	1st pick	2nd pick	TOTAL
FIRST YEAR ORCHARDS			
Colwell	1.2	-	**1.2**
Y/Stage	**	-	**
M/Twenty (%/1200)	0.3	-	**0.3**
E.A.T.	0.0	-	**0.0**
Rohner Home	0.1	-	**0.1**
Old Rickabaugh	0.2	-	**0.2**
Lone Pine - 2 sections			
East neck	1.3	-	**1.3**
Main block	0.4	-	**0.4**
M/Brown	0.7	-	**0.7**
Murphy (%/2000)	0.9	-	**0.9**
Young East	0.0	-	**0.0**
Quercus 20	0.0	-	**0.0**
Wide (%/2000)	0.0	0.0	**0.0**
Neck (%/2000)	0.0	0.0	**0.0**
Gaddy	0.0	-	**0.0**
BP Gaddy	0.0	-	**0.0**
Manning	0.0	-	**0.0**
AVERAGE FIRST YEAR	**0.32**	**0.0**	**0.32**
SECOND YEAR ORCHARDS			
Hedgerow	0.0	-	**0.0**
Renfro	0.1	-	**0.1**
Pardee-Lake	0.2	-	**0.2**
Morrison	0.0	-	**0.0**
Akins	0.0	-	**0.0**
Pardee-home	0.1	-	**0.1**
S/Stage (%/2000)	0.0	-	**0.0**
30 Acres	0.0	-	**0.0**
K-48	0.0	-	**0.0**
Cole	0.0	-	**0.0**
R/Brown	0.1	-	**0.1**
Young West	0.0	-	**0.0**
Sixty	0.0	-	**0.0**
Fourteen	0.0	-	**0.0**
Trailers	0.0	-	**0.0**
Triangle	0.0	-	**0.0**
AVERAGE SECOND YEAR	**0.03**	**-**	**0.03**
FIFTH YEAR ORCHARDS			
S/Timothy (%/1200)	0.0	-	**0.0**
M/Timothy (%/1200)	0.0	-	**0.0**
Sanderson	0.0	-	**0.0**
Cookson	0.0	-	**0.0**
Eutenier (%/1200)	0.0	-	**0.0**
AVERAGE FIFTH YEAR	**0.0**	**-**	**0.0**

** bin sample not reliable (pears were presorted before project team could sample)

2000 LAKE COUNTY PUFFER PROJECT
Oblique-Banded Leafroller Damage
August 7 - September 1, 2000, 1855 - 2421 °D
Bin Fruit Samples - %/1000

Table 6a:

TREATMENT/BLOCK	1st pick	2nd pick	TOTAL
PUFFER			
North-west Area			
Hedgerow	0.2	-	0.2
Renfro	0.4	-	0.4
Pardee-Lake	0.9	-	0.9
Morrison	0.4	-	0.4
Akins	6.0	-	6.0
Pardee-home	0.5	-	0.5
South-west Area		-	
Colwell	1.3	-	1.3
Y/Stage	**	-	**
M/Twenty (%/1200)	0.3	-	0.3
E.A.T.	0.3	-	0.3
Rohner Home	0.2	-	0.2
Old Rickabaugh	0.0	-	0.0
Lone Pine - 2 sections			
East Neck	0.8	-	0.8
Main block	2.4	-	2.4
M/Brown	1.1	-	1.1
Murphy (%/2000)	1.5	-	1.5
Mid Area		-	
S/Stage (%/2000)	0.2	-	0.2
30 Acres	0.4	-	0.4
S/Timothy (%/1200)	0.8	-	0.8
M/Timothy (%/1200)	0.3	-	0.3
K-48	0.0	-	0.0
Cole	0.1	-	0.1
Sanderson	0.4	-	0.4
Cookson	0.1	-	0.1
Eutenier (%/1200)	2.9	-	2.9
R/Brown	0.3	-	0.3
East Area Downwind		-	
Young West	0.3	-	0.3
Sixty	0.1	-	0.1
Fourteen	0.3	-	0.3
Trailers	0.0	-	0.0
Triangle	0.8	-	0.8
Young East	0.3	-	0.3
Quercus 20	1.4	-	1.4
Wide (%/2000)	0.2	0.0	0.1
Neck (%/2000)	0.4	0.6	0.5
Gaddy	1.1	-	1.1
BP Gaddy	1.4	-	1.4
Manning	9.2	-	9.2
AVERAGE PUFFER	1.0	0.3	1.00
GROWER CONTROL			
Springer (%/1200)	0.3	-	0.3
Quercus/Seven Acres	0.0	-	0.0
AVERAGE GROWER CONTROL	0.2	-	0.2
UNTREATED CONTROL			
Quercus/Seven Acres	7.3	-	7.3
Gold Dust1 (%/400)	2.4	-	2.4
AVERAGE UNTREATED	4.9	-	4.9

Table 6b:

2000 LAKE COUNTY PUFFER PROJECT

Oblique-Banded Leafroller Damage

August 7 -September 1, 2000, 1855 - 2421 °D

Bin Fruit Samples - %/1000

PROJECT YEAR/BLOCK	1st pick	2nd pick	TOTAL
FIRST YEAR ORCHARDS			
Colwell	1.3	-	**1.3**
Y/Stage	**	-	**
M/Twenty (%/1200)	0.3	-	**0.3**
E.A.T.	0.3	-	**0.3**
Rohner Home	0.2	-	**0.2**
Old Rickabaugh	0.0	-	**0.0**
Lone Pine - 2 sections			
East neck	0.8	-	**0.8**
Main block	2.4	-	**2.4**
M/Brown	1.1	-	**1.1**
Murphy (%/2000)	1.5	-	**1.5**
Young East	0.3	-	**0.3**
Quercus 20	1.4	-	**1.4**
Wide (%/2000)	0.2	0.0	**0.1**
Neck (%/2000)	0.4	0.6	**0.5**
Gaddy	1.1	-	**1.1**
BP Gaddy	1.4	-	**1.4**
Manning	9.2	-	**9.2**
AVERAGE FIRST YEAR	**1.4**	**0.3**	**1.4**
SECOND YEAR ORCHARDS			
Hedgerow	0.2	-	**0.2**
Renfro	0.4	-	**0.4**
Pardee-Lake	0.9	-	**0.9**
Morrison	0.4	-	**0.4**
Akins	6.0	-	**6.0**
Pardee-home	0.5	-	**0.5**
S/Stage (%/2000)	0.2	-	**0.2**
30 Acres	0.4	-	**0.4**
K-48	0.0	-	**0.0**
Cole	0.1	-	**0.1**
R/Brown	0.3	-	**0.3**
Young West	0.3	-	**0.3**
Sixty	0.1	-	**0.1**
Fourteen	0.3	-	**0.3**
Trailers	0.0	-	**0.0**
Triangle	0.8	-	**0.8**
AVERAGE SECOND YEAR	**0.7**	-	**0.7**
FIFTH YEAR ORCHARDS			
S/Timothy (%/1200)	0.8	-	**0.8**
M/Timothy (%/1200)	0.3	-	**0.3**
Sanderson	0.4	-	**0.4**
Cookson	0.1	-	**0.1**
Eutenier (%/1200)	2.9	-	**2.9**
AVERAGE FIFTH YEAR	**0.9**	-	**0.9**

** bin sample not reliable (pears were presorted before project team could sample)

Table 7a: 2000 LAKE COUNTY PUFFER PROJECT - Weekly 1XL Trap Catch Summary

(Blank areas indicate zeros)

.	Orchard Name				
Date	Gold Dust	Hanson	K-7	Y/Stage	Grand Total
4/4/00	0	1	0		1
4/6/00	0	0	0		0
4/11/00	1	0	0	0	1
4/18/00	1	0	1	0	2
4/25/00	0	0	0	0	0
5/2/00	3	0	0	0	3
5/9/00	4	0	0	1	5
5/16/00	0	0	0	0	0
5/23/00	12	0	0	0	12
5/30/00	0	0	0	0	0
6/6/00	1	0	0	0	1
6/13/00	0		0	0	0
6/20/00	4		0	0	4
6/27/00	0		0	0	0
7/4/00	1		0	0	1
7/11/00	2		0	0	2
7/18/00	0		0	0	0
7/25/00	0		0	0	0
8/1/00	1		0	0	1
8/8/00	3		0	0	3
8/15/00	0		0	0	0
8/22/00	7		1	0	8
8/29/00	1		0	0	1
9/5/00	1		0	0	1
9/12/00	0		0	0	0
Grand Total	42	1	2	1	46

Table 7b: LAKE COUNTY PUFFER PROJECT – Weekly 1XH Trap Catch Summary

.	Date																							Grand
Orchard Name	4/11	4/18	4/25	5/2	5/9	5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	Total
30 Acres	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Akins	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BP Gaddy	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Colwell	0	0	2	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Cookson	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E.A.T. Rickabaugh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Eutenier Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fourteen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaddy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gold Dust	2	3	1	3	10	1	4	0	0	4	3	1	0	0	0	0	1	0	0	1	3	1	1	39
Hanson	0	0	0	0	0	0	0	0	0															0
Hedgerow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	8	0	0	0	11
Lone Pine	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
M/Brown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/Timothy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/Twenty	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	6
Manning	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Morrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Murphy	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	8	0	0	0	11
Neck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Old Rickabaugh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Pardee-Home	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Pardee-Lake	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Q/Twenty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R/Brown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Renfro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rohner Home	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
S/Stage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S/Timothy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sanderson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sixty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trailers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triangle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnuts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Y/Stage	0	0	0	0	3	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	6
Young East	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Young West	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	2	4	4	3	24	1	4	1	0	8	3	1	0	0	8	1	1	0	0	19	4	1	1	90

TABLE 7c: 2000 LAKE COUNTY PUFFER PROJECT - Weekly 10XH Trap Catch Summary

Sum Of 10x Catches	Date																							Grand Total
Orchard Name	4/11	4/18	4/25	5/2	5/9	5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	
30 Acres	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Akins	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BP Gaddy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colwell	0	0	0	0	2	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	5
Cookson	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	4
EAT Rickabaugh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
Eutenier Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fourteen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaddy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Gold Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanson	0	0	0	0	0	0	0	0	0															0
Hedgerow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lone Pine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/Brown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M/Timothy	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
M/Twenty	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Manning	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Morrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Murphy	0	0	0	0	0	0	0	0	0	1	3	0	0	0	3	0	0	0	0	5	0	0	0	12
Neck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Old Rickabaugh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	4	0	0	0	6
Pardee-Home	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	4	0	0	0	7
Pardee-Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	4
Q/Twenty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R/Brown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Renfro	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	4
Rohner Home	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	3
S/Stage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S/Timothy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Sanderson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sixty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Springer	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Trailers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triangle	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Walnuts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Y/Stage	0	0	0	1	1	0	0	0	0	3	0	0	0	0	2	0	0	0	0	1	0	0	0	8
Young East	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Young West	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	1	0	0	2	5	0	0	0	0	13	7	3	0	1	13	4	1	0	0	24	1	0	0	75

Table 7d: 2000 LAKE COUNTY PUFFER PROJECT - Weekly OBLR Trap Catches

Orchard Name	5/16	5/23	5/30	6/6	6/13	6/20	6/27	7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	Grand Total
30 Acres	0	3	21	5	4	2	1	0	1	0	0	3	1	0	1	0	2	3	47
Akins	0	11	20	16	13	12	6	0	0	0	0	0	2	3	8	0	0	0	91
BP Gaddy	0	7	24	12	18	60	51	8	1	4	7	22	10	3	6	4	0	0	237
Cole	0	2	24	4	13	3	3	2	0	0	1	1	2	1	5	1	2	0	64
Colwell	0	11	15	5	15	0	0	0	0	0	0	0	0	4	0	2	0	1	53
Cookson	0	4	29	22	8	19	25	10	0	1	3	1	5	11	16	1	2	2	159
E.A.T. Rickabaugh	0	0	8	7	7	6	3	1	0	0	0	1	1	0	3	2	1	0	40
Eutenier Home	0	2	19	6	0	6	2	3	0	0	0	0	0	0	0	1	0	0	39
Fourteen	0	0	2	4	0	0	3	0	0	0	0	3	1	0	4	2	0	0	19
Gaddy	0	24	35	43	45	100	79	17	7	9	5	11	16	1	43	11	1	7	454
Hedgerow	0	5	16	22	18	21	10	4	1	1	1	8	9	5	24	6	0	0	151
K48	0	0	5	8	7	0	0	0	0	2	0	4	9	12	12	4	5	1	69
K-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lone Pine	0	8	22	4	13	13	2	4	1	1	0	3	1	7	3	1	0	0	83
M/Brown	0	3	8	0	0	0	6	2	1	0	0	0	0	2	1	0	0	0	23
M/Timothy	0	14	11	7	0	6	7	0	0	1	0	0	4	0	6	0	0	0	56
M/Twenty	0	20	31	2	20	11	1	4	2	0	1	6	3	2	14	6	4	7	134
Manning	0	7	17	15	18	42	23	21	1	1	2	1	11	2	13	6	0	8	188
Morrison	0	3	12	7	9	9	0	0	0	1	0	2	0	4	3	0	1	0	51
Murphy	0	12	58	48	36	62	58	23	4	2	3	3	7	2	1	1	5	1	326
Neck	0	36	91	25	87	76	41	6	4	3	2	13	23	8	10	5	2	2	434
Old Rickabaugh	0	5	6	4	7	5	3	2	0	1	1	1	3	5	2	6	0	3	54
Pardee-Home	0	19	24	38	18	5	4	2	0	1	0	1	0	2	1	0	2	2	119
Pardee-Lake	0	6	14	1	3	3	1	2	0	1	1	2	0	1	0	4	3	0	42
Q/Twenty	0	3	15	9	7	7	13	0	0	0	1	5	11	8	10	0	0	1	90
R/Brown	0	3	20	18	17	23	12	9	1	0	0	0	5	4	0	1	1	2	116
Renfro	0	4	6	6	5	5	2	0	0	1	0	1	4	2	2	0	0	0	38
Rohner Home	0	8	26	10	3	22	23	8	1	0	1	0	10	11	7	6	0	0	136
S/Stage	0	0	11	5	3	0	0	2	0	0	0	0	4	0	4	1	4	2	36
S/Timothy	0	0	4	0	0	2	0	0	0	0	0	0	0	0	3	2	0	0	11
Sanderson	0	0	2	2	4	4	5	0	3	0	0	1	3	0	3	0	0	0	27
Sixty	0	0	21	6	5	1	4	1	1	0	0	2	7	10	28	0	0	1	87
Springer	0	0	7	4	2	8	1	4	1	0	0	15	8	7	0	0	0	6	63
Trailers	0	0	8	4	1	1	1	0	0	2	1	2	8	5	9	2	0	0	44
Triangle	0	0	1	0	0	0	2	0	0	0	0	0	0	0	1	0	1	0	5
Walnuts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wide	0	9	22	31	24	35	17	11	3	5	6	12	13	9	23	8	3	3	234
Y/Stage	0	5	13	12	14	11	3	2	0	0	0	0	3	5	4	4	2	3	81
Young East	0	0	1	6	2	1	4	0	1	0	1	6	7	0	3	0	1	4	37
Young West	0	0	11	2	2	5	7	0	0	0	1	9	9	2	10	7	0	1	66
Grand Total	0	234	680	420	448	586	423	148	34	37	38	139	200	138	283	94	42	60	4004

Appendix III

University of California Cooperative Extension
Lake County
883 Lakeport Blvd., Lakeport, Ca. 95453
Tel: 707.263.6838
Fax: 707.263.3963

FACSIMILE COVER PAGE

To: Mark Lockhart	From: Lake County
Fax #: 263-1052	Fax #: 707-263-3963
Company: Ag Commissioner	Tel #: 707-263-6838

Subject: 2000 CM/OBLR PUFFER PROJECT	
Sent: 8/25/00 at 5:54:00 PM	Pages: 7 (including cover)

MESSAGE:

THIS FAX INCLUDES TRAP CATCHES FOR THE WEEK OF 8/22/00. THERE ARE 6 PAGES ARE NUMBERED 2 -7

WinFax PRO Cover Page

FAX UPDATE #18 August 25, 2000

Issued weekly to participating growers, PCA's, and project sponsors.

CAL DPR PUFFER PROJECT

Codling Moth

8/22-24 trap catch since biofix (using April 3). (Moth locations on attached maps)
ALL ZEROS EXCEPT:

	1XL	1XH	10XH	Total
Y/Stage	1		1	2
M/Twenty		1		1
Murphy		8	5	13
H/Rickabaugh		1	4	5
Cookson			1	1
[1] E.A.T. Rickabaugh			1	1
Morrison			2	2
Pardee Home			4	4
Pardee Lake			2	2
Renfro			3	3
Rohner Home			1	1
	1	10	24	35

[1] not yet picked

This is the largest catch this year and "echoes" the 1B flight that peaked June 13. This flight "snuck up" on me (with a vengeance). I am calling this the '2B' flight and still expect a true 3rd flight to occur around September 1. Catches correlate well with damage and were confined to the west and south blocks. Worms were already gone from many of the damaged fruit found in bins which corroborates this since normally newly-hatched larvae are found. THIS FLIGHT IS VERY CRITICAL; MOTHS ARE NOW LAYING EGGS ON REMAINING FRUIT. THESE WILL LIKELY DEVELOP AND OVERWINTER, EMERGING AS 1B MOTHS NEXT YEAR.

There are now five cohorts to be concerned about: 1A, 1B, 2A, 2B, and 3. Effects of the upcoming third flight will be less next year as the chances of larvae surviving in the fruit will decrease due to later emergence in this cool year.

IF YOU PLAN TO APPLY LORSBAN 4E, it should be applied ASAP for hatching larvae. This may be the final opportunity this season to counteract any existing resistance pressure since the true third flight continues to be delayed due to cool weather. If you do not apply Lorsban please survey your orchards after harvest and strip out noticeable clusters of fruit remaining in trees. Numerous small patches where fruit was left have been observed. As was seen in some (non-puffer) orchards this year, seemingly low populations have the potential to explode next year unless all precautions are taken.

Degree-day Accumulation

As of August 24 there were 1979 °D, at the KV PestCast station. The true third flight is now predicted to occur about August 31. Again, please make sure orchards are cleaned of as much remaining fruit as possible by this date (see above).

Damage and larval sampling

Bin counts are nearly complete. Out of 34 puffer blocks sampled so far, damage is averaging 0.2% and was found in 13 blocks (range 0.1 – 1.3%). All were either west of Soda Bay Road or south of Finley Road.

An adjacent non-puffer but pheromone-treated block to the south, which had noticeable damage, probably affected the south-edge blocks. This was corroborated by the gradient of decreasing damage from the south to Finley Road. Control on the west edge was likely hindered by 1) a large open area of grapes to the west creating more air flow. 2) the apple tree at the house on Soda Bay Road. 3) the old untreated check in the Stage orchard. There will be no bin counts listed for the Y/Stage as there was intensive sorting by pickers and bin sorters, making the "official" count unreliable (it was 0% and we know there were worms, probably 1.0 - 1.5%).

Several wormy fruit were found along the driverow between the Eutenier and Old Cookson orchards. There was some flight in the Cookson this year, and this find (the first since pre-1996) indicates the great CM pressure this year.

South and west "edge" orchards will all require first cover next spring using 3 lbs. of azinphosmethyl. The 1B flight may also need a second full 3 lbs. The big concern, of course, is the level of resistance going into 2001.

Given the amount of pressure this year, however, the program did exceedingly well, especially in blocks using puffers for several years and east of Park Drive. The final post-harvest sample will be completed by the end of September.

Orchard observations
Puffer orchards will likely need little or no post-harvest treatments for non-CM pests.

A couple of pears with damage resembling that of leaf-miners were found in the Eutenier Home orchard at harvest. Otherwise fruit was clean and the trees are in beautiful shape.

MIXED CM/OBLR PUFFER TRIAL
As of August 24, 2192 CM °D had been accumulated at the PV Adcon Station. The third flight is underway.

8/20 and 8/25 PV Codling Moth trap catches
ALL ZEROS EXCEPT:

Orchard	Set	8/20	8/25
Sides (CM/OBLR puffer)	1	10XH - 1	ALL ZEROS
Boynton (CM only puffer)	3	10XH - 3	
Untreated apples		1XL – 4 1XH – 6	

This is the main part of the true third flight that started the previous week. It appears the flight has ended.

Damage and larval sampling
The grower control was sampled August 22 and had no damage. A post-harvest sample will be done in mid to late September. Dan has done such an excellent job stripping the trees obtaining an adequate sample size may be difficult.

OBLR
8/22 -24 KV trap catches and OBLR °D accumulation (attached table and map):
Flight increased significantly this week. The highest catches were in the Gaddy, Hedgerow, Sixty, and Y/Stage.

As of August 24 there were 2238 OBLR °D at the KV PestCast station (based on 43 °F minimum and 85 °F maximum). According to the WSU model the second flight should be about 84% completed with 65% hatch. It is more likely about 67% complete with about 23% hatch.

In the two blocks with mixed CM/OBLR puffers catches were:

		8/16/99
Eutenier	0	0
S/Timothy	3	3

PV OBLR trap catches and degree day accumulation
As of 8/24 there were 2347 °D at the PV Adcon station.

8/20 AND 8/25 trap catches

	8/20		8/25	
Orchard	Set#	No.	Set#	No.
Boynton	5	1	5	2
(CM puffer only)	6	3	6	1

OBLR damage and larval sampling
KV bin samples thus far reveal 1.2% total OBLR damage with damage found in 34 out of the 35 blocks sampled so far. The only blocks without damage were the H/Rickabaugh and the K-48. There was a little brand new feeding indicating hatch of the second summer generation began but no new worms were found. Damage was 0.3% in the Springer grower control. Final tallies will be in next week's fax.

No OBLR damage was found in the PV grower control sampled August 22.

PUFFER UNIT UPDATE
The machines should be left in the orchard through September. Plan to remove them the first week of October. Take them down, stack them in a holding container of some sort (bins perhaps), cover the container and put them away until next spring. Punch a hole in the empty canisters and dispose of them as you would any empty household cleaner can. Plan to begin next year with NEW BATTERIES.

The units appear to have survived harvest fine. Several along Kelsey Creek were shot with a pellet gun prior to harvest and one was also broken by a thrown rock. The new units are more brittle than last year's units, which had thicker and more supple plastic.

Growing degree-days
This will be in next week's fax.

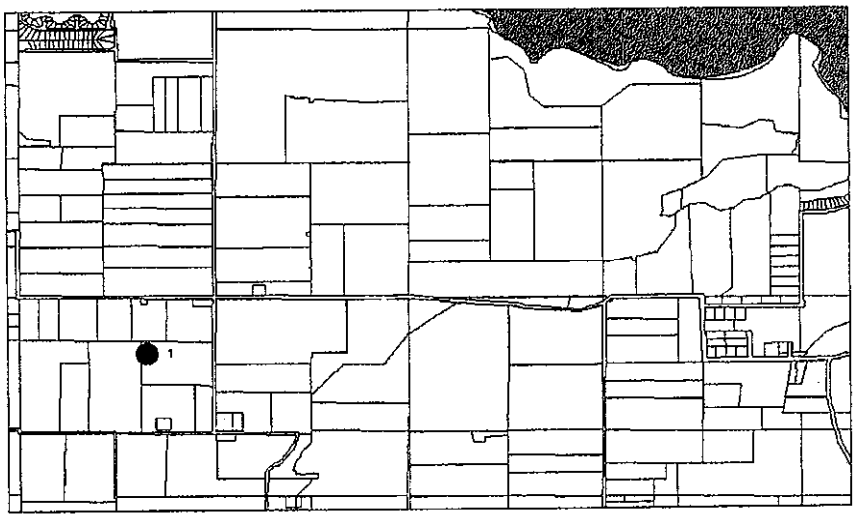
NOTE: I will be gone to the International Symposium on Pear Growing in Bologna, Italy from September 1-15. I am presenting two papers: the Bosc training and rootstock trial at Ken Barr's in Finley and the iron chlorosis trial at Don Eutenier's in Kelseyville; these will also be presented at the winter meetings. You will receive a fax next week with trap catches, degree-days, final bin counts, and growing degree-days, but without the commentary. Please discuss your situation with your PCA. The next fax after that will be sent on OCTOBER 6, and will summarize the entire season. I would like to call a meeting with the puffer group when I return to begin discussions about the 2001 season.

I hope you all get a little chance to rest; for those with grapes, happy harvest (again!)

Questions, comments, suggestions? Contact us! Until next week...

4

1xL



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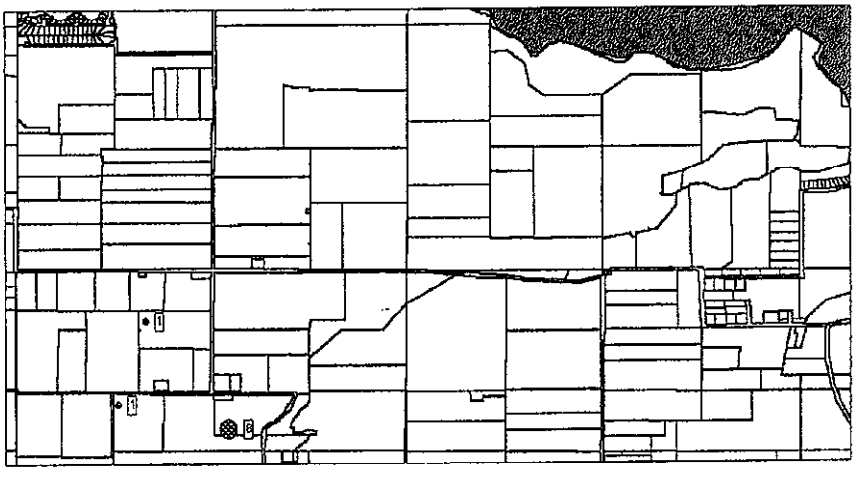
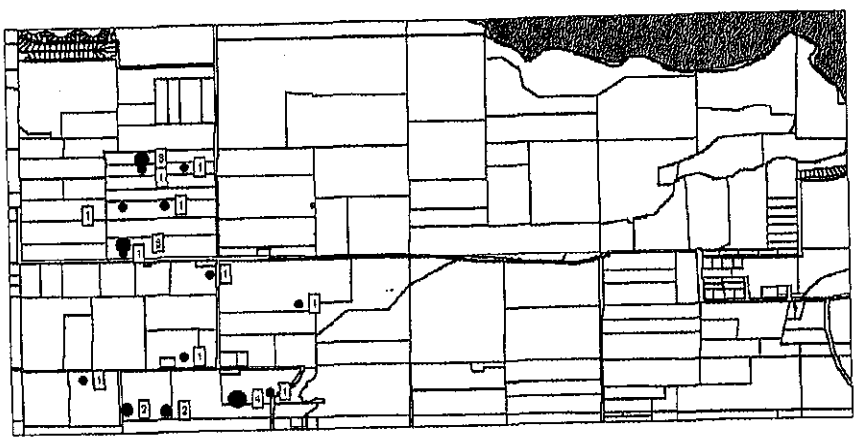
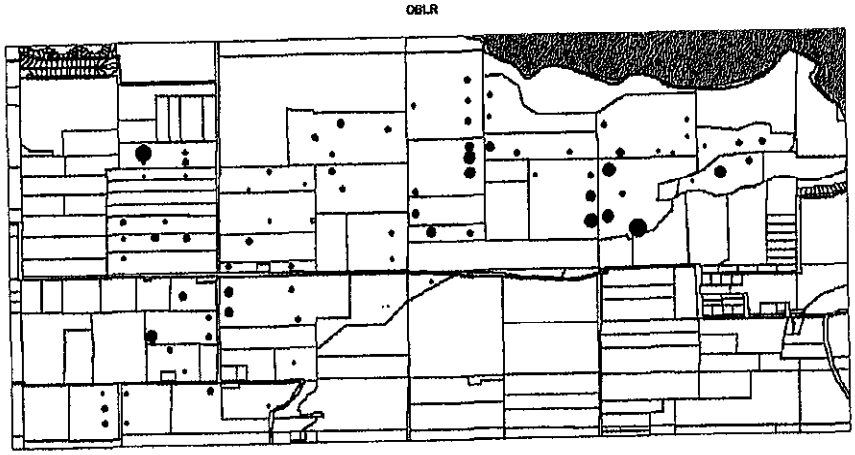


5

10xH



OBLR



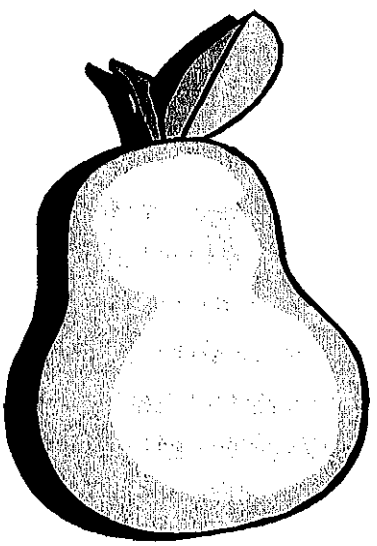
6

OBLR																
Orchard Name	5/16/00	5/23/00	5/30/00	6/6/00	6/13/00	6/20/00	6/27/00	7/4/00	7/11/00	7/18/00	7/25/00	8/1/00	8/8/00	8/15/00	8/22/00	Grand Total
30 Acres	0	3	21	5	4	2	1	0	1	0	0	3	1	0	1	42
Akins	0	11	20	16	13	12	6	0	0	0	0	0	2	3	8	91
BP Gaddy	0	7	24	12	18	60	51	8	1	4	7	22	10	3	6	233
Cole	0	2	24	4	13	3	3	2	0	0	1	1	2	1	5	61
Colwell	0	11	15	5	15	0	0	0	0	0	0	0	0	4	0	50
Cookson	0	4	29	22	8	19	25	10	0	1	3	1	5	11	16	154
E.A.T. Rickabaugh	0	0	8	7	7	6	3	1	0	0	0	1	1	0	3	37
Eutenier Home	0	2	19	6	0	6	2	3	0	0	0	0	0	0	0	38
Fourteen	0	0	2	4	0	0	3	0	0	0	0	3	1	0	4	17
Gaddy	0	24	35	43	45	100	79	17	7	9	5	11	16	1	43	435
Gold Dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanson	0	0	0	0												0
Hedgerow	0	5	16	22	18	21	10	4	1	1	1	8	9	5	24	145
Johnson																0
K48	0	0	5	8	7	0	0	0	0	2	0	4	9	12	12	59
K-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lone Pine	0	8	22	4	13	13	2	4	1	1	0	3	1	7	3	82
M/Brown	0	3	8	0	0	0	6	2	1	0	0	0	0	2	1	23
M/Timothy	0	14	11	7	0	6	7	0	0	1	0	0	4	0	6	56
M/Twenty	0	20	31	2	20	11	1	4	2	0	1	6	3	2	14	117
Manning	0	7	17	15	18	42	23	21	1	1	2	1	11	2	13	174
Morrison	0	3	12	7	9	9	0	0	0	1	0	2	0	4	3	50
Murphy	0	12	58	48	36	62	58	23	4	2	3	3	7	2	1	319
Neck	0	36	91	25	87	76	41	6	4	3	2	13	23	8	10	425
Old Rickabaugh	0	5	6	4	7	5	3	2	0	1	1	1	3	5	2	45
Pardee-Home	0	19	24	38	18	5	4	2	0	1	0	1	0	2	1	115
Pardee-Lake	0	6	14	1	3	3	1	2	0	1	1	2	0	1	0	35
Q/Twenty	0	3	15	9	7	7	13	0	0	0	1	5	11	8	10	89
R/Brown	0	3	20	18	17	23	12	9	1	0	0	0	5	4	0	112
Renfro	0	4	6	8	5	5	2	0	0	1	0	1	4	2	2	38
Rohner Home	0	8	26	10	3	22	23	8	1	0	1	0	10	11	7	130
S/Stage	0	0	11	5	3	0	0	2	0	0	0	0	4	0	4	29
S/Timothy	0	0	4	0	0	2	0	0	0	0	0	0	0	0	3	9
Sanderson	0	0	2	2	4	4	5	0	3	0	0	1	3	0	3	27
Sixty	0	0	21	6	5	1	4	1	1	0	0	2	7	10	28	86
Springer	0	0	7	4	2	8	1	4	1	0	0	15	8	7	0	57
Trailers	0	0	8	4	1	1	1	0	0	2	1	2	8	5	9	42
Triangle	0	0	1	0	0	0	2	0	0	0	0	0	0	0	1	4
Walnuts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wide	0	9	22	31	24	35	17	11	3	5	6	12	13	9	23	220
Y/Stage	0	5	13	12	14	11	3	2	0	0	0	0	3	5	4	72
Young East	0	0	1	6	2	1	4	0	1	0	1	6	7	0	3	32
Young West	0	0	11	2	2	5	7	0	0	0	1	9	9	2	10	58
Grand Total	0	234	680	420	448	586	423	148	34	37	38	139	200	138	283	3808

7

Appendix IV

NORTH COAST PEAR FIELD DAYS 2000



July 13 & 14, 2000

Sponsored by:

University of California Cooperative Extension
California Department of Pesticide Regulation
California Pear Advisory Board
Pear Pest Management Research Fund
Ukiah Valley IPM Pear Growers, Inc.

2000 UC LAKE COUNTY PEAR FIELD DAY
Thursday, July 13, 2000

SPONSORS:

U.C. Cooperative Extension
California Department of Pesticide Regulation
California Pear Advisory Board (CPAB)
Pear Pest Management Research Fund

3 units PCA Continuing Education Credit applied for

For both sessions, meet at Quercus Ranch, 4150 Soda Bay Road, Kelseyville. Follow parking signs to labor camp. The meeting will then progress to local orchards on Soda Bay Road.

SPANISH SESSION: 12:30 - 3:00 p.m. (Registration at 12:30 p.m., program begins at 1:00)
Translation by Lucia Varela (*Please encourage employees to attend at least one of the Spanish sessions in Lake or Mendocino County – for* **your** *benefit as well as theirs!!)* A HAND LENS WILL BE GIVEN TO EACH ATTENDEE.

ENGLISH SESSION: 3:30 – 6:00 p.m. (Registration at 3:30, program begins at 4:00)

PROGRAM
(same for English and Spanish sessions)

- **Registration, refreshments, welcome**
  Rachel Elkins, U.C. Cooperative Extension, Lake and Mendocino Counties

- **Oak root fungus management and using the pressure bomb to measure tree stress**
  HANDS-ON PRACTICE USING THE NOW-COMMERCIAL "SHACKEL" PRESSURE BOMB MADE BY PMS INSTRUMENTS
  Rachel Elkins and field staff
  Dave Rizzo, Dept. of Plant Pathology, UC Davis
  Ken Shackel, Dept. of Pomology, UC Davis
  Jeff Hamel, PMS Instrument Co., Corvallis, OR

- **Pear Pest Management Alliance late-season pheromone hanging (final update)**
  Rachel Elkins
  Participating growers and PCA's
- **CalDPR/PMA areawide codling moth "puffer" project**
  DISCUSSION AND HANDS-ON PRACTICE WITH DISPENSERS AND PROGRAMMER
  Rachel Elkins and field staff, UCCE
  Bob Elliott, CalDPR Project Manager
  Roland Gerber, Paramount Farming Co., Bakersfield
  Bob McClain, CPAB
  Participating Growers and PCA's

- **European pear variety trial – 2000 observations and fruit viewing**
  Rachel Elkins

- **ADJOURN**

Those who wish to view and discuss the 8th leaf Golden Russet Bosc training and rootstock trial in Finley are welcome to join us after the English meeting ends at 6:00. Training systems are central leader, 3-leader, 'parallel hedgerow', perpendicular fan and Tatura trellis. Rootstocks are OHxF 40, 69, 87, 97, 217, 333, and 513, Quince BA29C and *P. betulaefolia.*

UPDATE ON THE LAKE COUNTY AREAWIDE CODLING MOTH 'PUFFER' PROJECT
(for Gerber Integrated Pest Management Newsletter) (in progress)

By Rachel Elkins

Ten growers farming a total of 820 acres in Kelseyville, Lake County, California utilized the "puffer" pheromone dispensing system to control codling moth in 2000. The dispenser was developed the late UC entomologist Dr. Harry Shorey and is now known as the Paramount Aerosol Pheromone Dispenser (Paramount Agricultural Technologies, Bakersfield, California). It emits a preset amount of pheromone at present times and intervals. It is widely spaced (65 feet apart), mainly around the perimeter of the orchard at about one to two per acre. The rate used in Lake County in 2000 was 1.1, or a half unit per acre fewer than when the project began on 163 acres in 1996.

Codling moth damage averaged 0.15% in 2000, with almost all damage in first year and/or upwind blocks. Orchards that had been in the program for two or more years had virtually no damage. This was in contrast to an average of 48% damage in untreated controls.

Another important benefit in multiple year orchards was the reduced level of pesticide use for pear psylla and spider mites. Orchards treated one or more times with organophosphates (especially 2-3 times) suffered pear psylla and, more significantly, mite damage late in the season which required extra treatments. Savings, however, were offset by the need to apply a pre-bloom application of chlorpyrifos (i.e. Lorsban®) and one or two follow up BT sprays to control oblique-banded leafrollers, which have become the main secondary pest in codling moth mating disruption programs.

The continuing success of the Lake County project has attracted new participants and next year the project will encompass approximately 1460 acres farmed by 19 growers. Research is continuing to control OBLR without the use of OP's, although chlorpyrifos will continue to be an important tool until adequate alternatives are found. Costs and benefits of initiating and remaining in a puffer MD program are also being documented in collaboration with the Department of Agricultural Economics at UC Davis.

The project was recently recognized as one of eight statewide recipients of the IPM Innovator Award sponsored by the California Department of Pesticide Regulation. The growers, pest control advisers, and project sponsors (including Gerber), can be proud of their commitment and achievement.

Appendix V

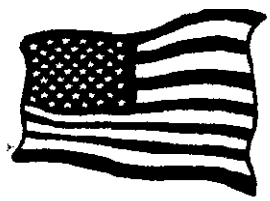
Making Our Best....Better

Gerber

Integrated Pest Management Newsletter

Year 5, Issue 10 Spring 2000

Editorial by Todd DeKryger



"From Sea to Shining Sea"

As we move into the summer season and head towards Independence Day on the Fourth of July, we celebrate all that is good in America and we reflect on how we got here as a nation. As we look around this nation, there are many examples of the innovation of the American farmer and how they have worked with the land, not against it, to produce a bountiful harvest of a variety of crops.

This edition of "Making Our Best...Better" is designed to highlight some of the agricultural research projects going on throughout the country that Gerber Products Company is involved with. The projects range from apple growers getting together in the Carolinas to address production problems facing their industry to pear growers tackling codling moth using novel control strategies in Northern California. All across our nation, growers are facing challenges with innovation and determination just like they always have. Gerber Products Company has been a part of that process since our beginning.

Gerber Products Company started in Michigan in 1901 as the Fremont Canning Company processing a number of different canned fruits, vegetables and meats. Today, our domestic market covers all 50 states and we source fruits and vegetables from 21 of those 50 states. As an important part of the Novartis Consumer Health family, Gerber Products Company has been a global leader in infant nutrition and healthcare products for many years.

As a researcher for a global company, I have the privilege and responsibility to go to many fruit and vegetable growing areas around this country. Part of my job is to learn as much about each growing area as possible so that the dollars Gerber provides for agricultural research each year effectively addresses the production concerns that our growers face each day.

While change is never easy, there are numerous examples of growers across the nation who are addressing the challenges faced by their industry and are equipped to compete on a global market. These innovative growers are competing in a highly competitive world market and succeeding. Gerber Products Company is proud to be associated with many of these growers.

Todd DeKryger

The words of "America, the Beautiful" ring as true today as they did when they were written. "O beautiful for spacious skies, for amber waves of grain...." Katharine Lee Bates had it right when she penned those words in 1895. One of the stories about Ms. Bates suggests that she was inspired to write the poem after visiting Pikes Peak in the Colorado Rocky Mountains. I must confess that the innovation of the American fruit and vegetable grower inspired me to write this newsletter. While I am sure that this edition of "Making Our Best...Better" won't become as famous as "America, the Beautiful," I hope that it will effectively highlight a few of the many innovative programs in progress throughout this beautiful country.

Above the Fruited Plain (cont'd)

One of the most important factors in the success of this program will be the communication between the peach growers and their pest control advisors (PCAs). This communication will be important for improving the timing of the biological insecticides and the effectiveness of the applications. To facilitate the communication, Janine Hasey, a Farm Advisor in Sutter and Yuba Counties north of Sacramento, will hold grower meetings during the season as well as provide individual contact with the participating growers. Gerber Products Company provided a grant to the program to cover the cost of the IPM scouting for the growers.

Janine Hasey holding a peach grower meeting.

A grower checks the Oriental fruit moth monitoring trap in the peach tree.

Leaf and flower spur samples were taken from the dormant trees in January to determine the baseline populations of pests such as the San Jose scale and the European red mite. The levels of parasitism from predator insects in the scale and mite populations were also determined at that time. Based on this information from the PCA's, applications of dormant oil were applied to the orchards when needed.

In February and March, the program's IPM scout monitored the orchards for the peach twig borer emergence and all blocks will be treated with Bacillus thuringiensis at 20 - 40 % egg hatch. A second treatment will be applied at 80 - 100 % egg hatch. Bacillus thuringiensis is a bacterium that produces a toxin that is a stomach poison for certain species of insects. This naturally occurring insecticide is considered harmless to humans. The toxin is very short-lived and needs multiple applications to maintain effective control.

The mating disruption pheromone dispensers were put in the orchard in March to target the 1st generation of Oriental fruit moth. Orchard blocks will be monitored for shoot strikes from May until harvest and fruit strikes as the fruit ripens. Secondary insect pests, such as two-spotted mites, will also be monitored on a regular basis. If a particular orchard block develops pest populations exceeding the threshold for potential damage during the growing season, a Gerber field representative and the PCA will be contacted before the decision is made to apply an insecticide application. The fruit will be assessed for insect damage at harvest.

Codling Moth Mating Disruption in California Pear Orchards Using an Aerosol Pheromone Dispenser

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Mating disruption has become a major control strategy used in integrated pest management (IPM) programs in California tree fruit orchards. It involves inundating one or a group of orchards with large amounts of the chemical females emit to attract potential mates. These chemicals as a group are called pheromones, and in the case of codling moth (CM), the major pest of pome fruit, the pheromone is called "codlemone."

Knowledge of how pheromones work and how to synthesize them led to the development of the monitoring traps that are now standard orchard IPM tools. Under normal circumstances, female CM emit a trail of a very small quantity of codlemone as they fly. Males can detect this trail from a long distance and use it to seek out a mate. Trapping works because the male detects the pheromone and follows it to the source, which is an

artificial lure in a trap rather than a virgin female moth.

Entomologists have long been interested in using pheromones as a control method as well as simply a monitoring tool. Mass trapping is one well-known strategy and involves hanging numerous pheromone traps that literally "trap out" all the moths in an orchard. This method has been utilized most successfully in small orchards and by organic growers with limited control options. Modern mating disruption (MD) programs now represent the most commonly practiced control strategy using pheromones.

The commercial MD strategies used in orchards today were implemented in the early 1980's following research done in the 1960's - 1970's. Several companies introduced various types of dispensers to disrupt mating of pests such as cotton bollworm, artichoke plume moth, and oriental fruit moth. Pacific BioControl successfully tested a product for use in pear orchards against CM in the Sacramento Valley of California in 1987. Their Isomate C® product was first sold in 1991.

The aerosol pheromone dispenser hanging in a pear tree.

There are now several CM pheromone dispensers being sold, most of which utilize multiple "point sources." This strategy employs many dispensers (200-400 per acre) each of which emits a small amount of pheromone through a porous membrane. Users hang, twist or clip them into the upper parts of trees according to a pattern determined by tree spacing.

Several problems associated with early dispensers slowed widespread adoption until recently. Two of the main ones were poor control when insect populations were high and erratic release rates, mainly due to ambient temperature changes. Another major drawback was total program cost. Besides product cost of about $200 per acre, labor costs to apply up to 400 units per acre, often twice per season, ranged from $15-30 per acre per application. Most orchards also required one or more supplemental insecticide sprays that further increased costs.

In response to some of the above issues, the late Dr. Harry Shorey of UC Riverside developed a dispenser that emitted a large amount of pheromone and was spaced widely apart. Dr. Shorey was a pioneer in the field of pheromone-based control technology. He theorized that the number of "point sources" was less important than having an adequate, **consistent** pheromone dose permeate the orchard. Dispersal studies showed him that a given amount of pheromone moved with air currents laterally and outwardly far beyond the initial emission point. **As long as emission rates remained constant,** pheromone from a relatively small number of dispensers moved and mixed throughout the treated area.

The dispensers are placed in the upper branches of the pear tree.

Dr. Shorey utilized the aerosol dispensers commonly found in lavatories and kitchens. These battery-powered units emit a pre-programmed amount of room freshener at set intervals 24 hours per day. Dr. Shorey loaded the pressurized canisters with pheromone instead of perfume. He then modified the programming to emit based on when the target insect flew and mated, rather than 24 hours a day; this extended the field life of the dispenser. The unit was also unaffected by temperature or particulate matter so emission rate was stable from the start to the end of the season. The most attractive benefit for growers, however, was the labor savings. Shorey's goal was to limit application rates to a maximum of two units per acre, hung from the ground around the field perimeter. This would eliminate most of the application costs. Each year, a new canister would be placed in the plastic outer unit and re-hung, so after initial purchase, material cost would also go down.

Dr. Shorey called his dispenser the "puffer." The first tests of his "puffer" in California pear orchards were conducted in 1996. A major project was funded by the Pear Pest Management Research Fund, a joint grower-processor group dedicated to furthering new pest management strategies (Gerber belongs to the PPMRF). 160 acres in Lake County on the North Coast were initially treated with one dispenser per 1.3 acres. Traps, egg samples, and damage counts were used to evaluate codling moth control. The end results will be briefly summarized below (complete details may be obtained from the author).

In 1996, total damage in areas where CM was controlled only with puffers was less than 1% and was

(Codling Moth Mating Disruption in California Pear Orchards Using an Aerosol Pheromone Dispenser continues on page 8)

Codling Moth Mating Disruption in California Pear Orchards Using an Aerosol Pheromone Dispenser (cont'd)

limited to upwind blocks. The same 160 acres was retreated in 1997 and 1998, with increasingly promising results. Tragically, Dr. Shorey died in a car accident in late summer 1998, so his inspiration and ideas were suddenly lost. Participating growers, however, decided to carry on with the project, and in 1999 it was expanded to 500 acres with funding from the USDA Codling Moth Areawide Project (CAMP). The California Department of Pesticide Regulation provided funds to treat an additional 360 acres in Potter Valley, Mendocino County.

After Dr. Shorey's death, development of his "puffer" was taken over by Paramount Farming Co., a large almond and pistachio grower/processor in the southern San Joaquin Valley. The company wanted to use it on its ranches against peach twig borer and Oriental fruit moth. The codling moth unit was registered as the "Paramount Aerosol Pheromone Dispenser" in late 1999 and made commercially available to other growers in 2000.

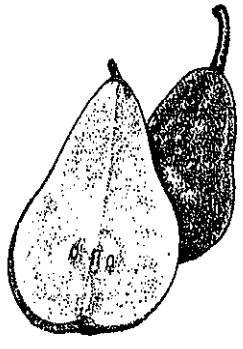
1999 results continued to be excellent. There was virtually no CM trap catch or damage in the Lake County treated acreage. Damage in Potter Valley occurred only in organic blocks, along borders of standard blocks adjacent to the organic ones, and along one riparian corridor harboring feral apple seedlings. These results were achieved despite the fact that in Lake County only about 35% of the acreage received an organophosphate (OP) spray and 100% of the Potter Valley acreage received no OP treatments at all.

After the 1999 season, participating Lake County growers chose to again expand the project to its current 820 acres using a rate of 1.1 units per acre, and it is still the primary control method for 75 acres of organic pears in Potter Valley. There have been very few moths caught to date in 2000 and no CM eggs found except in standard insecticide and untreated controls. Damage after the first and second generation will again be evaluated to determine efficacy. If the Lake County acreage expands in 2001, the application rate should fall below one per acre, generating further cost savings.

After almost five years, researchers and users have learned much about the strategy. The dispenser is a mechanical device programmed by a computer. Batteries must be replaced annually and units checked periodically. The programming unit must be set correctly to ensure the proper emission rate, interval and times. Units must be left hanging undisturbed by field workers and harvest crews. They must be taken down at season's end, cleaned, and stored until the next season. If properly cared for, they should last five years.

Like other mating disruption programs, the Lake and Mendocino projects have had problems of secondary pest outbreak and need for supplemental chemical control in high-pressure orchards. The most severe secondary pest problem is oblique-banded leafroller (OBLR). A mixed CM/OBLR dispenser is being tested this season in two orchards in Lake and one in Mendocino County. If it is successful, the mixed canister should be commercially available within a couple of years. Pre-bloom applications of the OP Lorsban® and/or in-season applications of BT (e.g. Dipel®) and the insect growth regulator tebufenozide (Confirm®) are presently being used to control OBLR. True bugs have also been a sporadic problem and damage is expected to increase as OP use declines.

In summary, the "Shorey puffer," now known as the "Paramount Aerosol Pheromone Dispenser," like other types of dispensers used in mating disruption programs, appears to be a promising tool if managed wisely.



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Appendix VI

Sample Costs

To produce Bartlett pears
In Lake County, California
Using

PUFFERS

An amendment to the 1997
Lake County cost study

Rachel Elkins
Karen Klonsky
Dustin Blakey

Abstract

Sample costs to produce Bartlett pears in Lake County have been compiled most recently in 1997 using standard production practices of the time. Growers at that time were assumed to make three cover spray applications with organophosphate materials to control codling moth. The advent and recent use of aerosol-released pheromone mating disruption ("puffers") created a need for a cost comparison of the two production systems. Man-hours were recorded for all operations that were considered to be part of a diligent, puffer-based codling moth control program. A model spray program was created that was representative of the sprays applied to puffer acreage according to submitted monthly pesticide use reports. The cultural expenses of the 1997 cost study were amended by adding any additional costs incurred from using puffers and by subtracting any savings. For a 40-acre block, it is recommended to use 2 puffers per acre. As contiguous acreage increases, this rate can be reduced. In this study a rate of 1.3 puffers per acre is used in a 500-acre contiguous block of orchards. One trap set (4 traps) is used every 5 acres to monitor insect development. All other 1997 costs, fees, and interest rates were used when possible so that there could be a valid basis for comparison. To produce pears using standard practices cost $1,847 per acre; using a puffer program cost $2,042 per acre (1997 dollars). A net additional expense of $194 was incurred by using puffers. Use of an improved design puffer cabinet (available in 2000), a reduced number of traps per acre, and elimination of the remaining cover spray would lower costs of production using puffers by reducing material and labor expenses. In subsequent years, the cost of the reusable puffer cabinet would be eliminated.

Table 1. Labor used for operations related to using puffers to produce pears. Amounts given are in man-hours per acre (6 min = 0.1 hours).

Operation	MAR	APR	MAY	JUN	JUL	AUG	SEP
Hang Puffers	0.08	-	-	-	-	-	-
Hang CM Traps	0.07	-	-	-	-	-	-
Change Lures (caps)	-	0.125	0.125	0.125	0.125	0.125	
Check Traps	-	0.144	0.37	0.4	0.28	0.29	0.11
Hang OBLR Traps	-	-	-	0.1	-	-	-
Egg Counts	-	-	0.046	0.046	0.046	-	-
Check Ground Fruit	-	-	-	-	0.064	-	-
Check Tree Fruit	-	-	-	0.172	0.172	-	0.086
Inspect Puffers	0.02	0.02	0.02	0.02	0.02	0.02	-
Compile Weekly Results	-	0.03	0.03	0.03	0.03	0.03	0.03
Bin Counts	-	-	-	-	-	0.24	-
Take Down Traps	-	-	-	-	-	-	0.112
Reprogram Puffers*	-	-	-	-	0.09	-	-

*Not included in cost study.

Table 2. Material costs for puffers and traps. 1999 Prices shown ($US).

Material	Cost	Rate/Acre
Puffer Cabinet	$40.00	1.3
Puffer Canister	$80.00	1.3
Traps*	$32.96**	0.8

* Includes all lures and replacement liners. Average cost of CM and OBLR types.
** Assumes 4% bulk discount over retail, single case price. Discount will vary with quantity purchased.

Cost of traps.

As the cost of one trap used through a season may seem high, the method by which it was calculated is shown in Table 3. These prices reflect full retail prices quoted by Trece in late 1999 less a 4% discount for buying a reasonable quantity. For a quantity of traps to cover 700 acres, the researchers obtained a more sizable discount. A set of traps consists of four traps: 1xCM high, 1xCM low, 10xCM high, and OBLR-W high.

Table 3. Itemized list of costs used to calculate average cost of one trap.

Item	Qty	Price	Price/100	Needed	Cost of 100
1x CM Lures	25	$43.17	$172.68	10	$1,726.80
OBLR-W Lures	25	$43.17	$172.68	5	$863.40
10x CM Lures	25	$27.38	$109.52	3	$328.56
Liners	100	$94.29	$94.29	3	$282.87
Traps	100	$231.34	$231.34	1	$231.34
				Total	$3,432.97
				Less 4% discount	$3,295.65
				Cost per trap	$32.96

Sample Spray Program.

This is the spray program used in conjunction with puffers for pear pests in our cost study. This is a transition orchard and will receive one cover spray with Guthion. This does not include dormant oil, herbicide, or disease sprays. *This is only an example and may not reflect the actual program in every orchard.*

MARCH
- Lorsban, 3 lb / ac
- Asana XL 7.25 oz / ac

APRIL
- Asana XL 7.25 oz / ac

MAY
- Guthion 2 lb / ac
- Agri-mek 15 oz / ac (with oil)

JUNE
- Dipel 2 lb / ac

JULY
- Dipel 2 lb / ac

Table 4. Cultural costs to produce pears using standard practices. Unchanged 1997 cost study amounts.

Beginning JAN 97 Ending DEC 97	JAN 97	FEB 97	MAR 97	APR 97	MAY 97	JUN 97	JUL 97	AUG 97	SEP 97	OCT 97	NOV 97	DEC 97	TOTAL
Cultural:													
Pest Control - Dormant		55											55
Weed Control - Strip Spray 3X		31		10			9						50
Pest Control - Gophers 3X			7										7
Pest Control - Budbreak			16										16
Weed Control - Mow Middles 7X			8	8	8	14	14						50
Pest Control - Scab			35	5									40
Frost Protection				24	24								48
Pest Control - Fungicide Spray				11	59								71
Pest Control - Blight				65	65								131
Pest Control - Blight & Scab				22									22
Prune & Train Trees					792								792
Pest Control - Blight & Cover					38								38
Pest Control - Cover Spray						44	22						66
Irrigate						29	29						58
Fertilize - Nitrogen						34							34
Pest Control - Psylla & Mites						17	155						172
Apply Hormone								28					28
PCA Fees		4	4	4	4	4	4	4	4				33
Leaf Analysis					19								19
Pickup Truck Use	5	5	5	5	5	5	5	5	5	5	5	5	62
ATV Use	5	5	5	5	5	5	5	5	5	5	5	5	57
TOTAL CULTURAL COSTS	10	100	79	159	1019	152	242	42	14	10	10	10	1847

Table 5. Cultural costs to produce pears using puffers. Labor and chemical costs are from 1997. Traps and puffers are 1999 prices. Changes to 1997 study are indicated in *italic* type.

Beginning JAN 99 Ending DEC 99	JAN 99	FEB 99	MAR 99	APR 99	MAY 99	JUN 99	JUL 99	AUG 99	SEP 99	OCT 99	NOV 99	DEC 99	TOTAL
Cultural:													
Pest Control - Dormant		55											55
Weed Control - Strip Spray 3X		31		10			9						50
Pest Control - Gophers 3X			7										7
Pest Control - Budbreak			16										16
Weed Control - Mow Middles 7X			8	8	8	14	14						52
Pest Control - Scab			35	5									40
Frost Protection				24	24								48
Pest Control - Fungicide Spray				11	59								70
Pest Control - Blight				65	65								130
Pest Control - Blight & Scab				22									22
Prune & Train Trees					792								792
Pest Control - Blight & Cover					38								38
Pest Control - Cover Spray													*0*
Irrigate						29	29						58
Fertilize - Nitrogen						34							34
Pest Control - Psylla & Mites			*13*	*13*	*102*								*128*
Change Caps				*1*	*1*	*1*	*1*	*1*	*1*				*6*
Check Traps				*2*	*2*	*2*	*2*	*2*	*2*				*12*
Egg Counts					*0.5*	*0.4*	*0.5*						*1.4*
Check Tree + Ground Fruit & Bins						*0.75*	*0.75*	*0.75*	*0.75*				*3*
Compile Weekly Results				*1*									*1*
Hang Puffers			*157*										*157*
Hang OBLR Traps						*7*							*7*
Inspect Puffers			*1*										*1*
Hang CM Traps			*20*										*20*
Pest Control - OBLR			*36*			*29*	*29*						*94*
Take Down Traps									*1*				*1*
Apply Hormone								28					28
PCA Fees		4	4	4	4	4	4	4	4				32
Leaf Analysis					19								19
Pickup Truck Use	5	5	5	5	5	5	5	5	5	5	5	5	60
ATV Use	5	5	5	5	5	5	5	5	5	5	5	5	60
TOTAL CULTURAL COSTS	10	100	307	176	1125	132	100	45	18	10	10	10	2042

Table 6. Cost comparison of standard and puffer blocks.

Production Type	Cultural Cost
Standard	$1,847
Puffer	$2,041

Table 7. Comparisons of various hypothetical production regimes using puffers at full- and half-rate trap coverage (1 trap per 1.25 acres vs. 1 trap per 2.5 acres) based on 1997 cost study.

Program	One-half trap rate	Full trap rate
Year 1 program	$2,019	$2,042
In year 2 with one cover spray	$1,967	$1,990
Same but with no cover sprays	$1,945	$1,968
Year 2 using mixed OBLR-CM canister, 1 Lorsban application & 1 CM cover	$1,909	$1,932
Year 2 mixed OBLR-CM, no CM spray, 1 Lorsban	$1,887	$1,910
Standard production (1997 Study)	$1,848	$1,848

Areawide Management of Codling Moth in Mendocino Orchards

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Lucia Varela, North Coast IPM Advisor

Cooperators:
Growers: Steve Giannecchini, Mike Hildreth, Wallace Hooper, Bill Johnson, Frank Johnson, Ron Ledford, Bruce Ledford, Tim Norgard, Miles Oswald, Morgan Ruddick, Chris Ruddick, Matt Ruddick, Richard Ruddick and Rick Ruddick, Randy Ruddick.
Pest Management Consultants: Pete Chevalier and Bill Oldham

Abstract

This was the fifth year of an implementation program in the Mendocino pear district aimed at facilitating and broadening the adoption of codling moth mating disruption. This year the acreage under the project (1030 acres) remained approximately the same as last years. Organophosphate use for codling moth control was reduced by 87% from the average of three OP cover sprays per year used from 1991 to 1995. There was an increase in codling moth populations in several blocks and a slight increase in leafroller damage. Boxelder bug damage was observed in the first 10 rows from the Russian River. This was the second year where the management of the project was under the Ukiah Valley IPM Pear Growers Coalition.

Objectives:

1) Implement areawide management of codling moth with pheromone mating disruption in Mendocino County pear orchards.
2) Estimate the impact of individual grower practices on program efficacy and reliability.
3) Implement non-disruptive controls of secondary pests and supplemental codling moth control.

Introduction

An areawide management of codling moth using mating disruption was initiated in Mendocino County in 1996 on 400 contiguous acres of pears. It increased to 550 acres in 1997, to 900 acres in 1998 and to 1050 acres in 1999 (see Table 1).

Mating disruption applied on a regional scale has provided pear and apple growers with an alternative to frequent organophosphate-based management strategies and an improvement in efficacy compared to single-farm approaches. Areawide management appears to reduce the risk associated with pesticide use and increases the ability of natural enemies to regulate populations of secondary orchard insect pests and thus provides a more sustainable and stable pest management program.

The primary insecticides used for codling moth control are the organophosphates Guthion and Imidan. These organophosphates will be affected by the implementation of the Food Quality Protection Act of 1996. New less-disruptive chemicals must be implemented as supplemental control. As new insecticides are implemented for supplemental control in the coming year, monitoring and evaluation will become critical for the success of the program.

Successful adoption of mating disruption is based on acquiring confidence in monitoring codling moth under mating disruption and determining when further measures are needed. Predicting codling moth damage under mating disruption requires intensive monitoring and experience in assessing trap catches. Major concerns in blocks under pheromone confusion are controlling codling moth in orchard borders, the reliability of trap monitoring, and the appearance of secondary pests such as leafrollers.

Organophosphate use for codling moth control was reduced by 66%, 80%, 82% and 95% in 1996 through 1999, respectively (see Table 1D). With an intensive monitoring regimen, we were able to predict and control codling moth "hot spots". There was a slight increase in leafroller damage in 1996 through 1999. Pests of increased concern were various true bugs, including boxelder, lygus and stink bugs. The greatest damage was observed in the rows adjacent to the Russian River, due to boxelder bug. In block that did not receive an OP spray, there was no spider mite or psylla damage. We hypothesize that conditions under mating disruption are more favorable for integrated control of secondary pests, thus lessening the probability that the threshold levels for mite or psylla outbreaks would be exceeded. The reduced need for insecticide applications for secondary pests will offset the higher cost of mating disruption technology. Since the project began in 1996 we were able to eliminate post-harvest clean-up sprays for mites.

Materials and Methods

Pheromone mating disruption was used as the key technique for managing codling moth. One application of BioControl Isomate-C+ dispensers at a rate of 400 dispensers per acre was applied on 30% of the acreage (see Table 1B). The other 70% of the acreage received one application of Concept Checkmate dispensers at a rate of 160 dispensers per acre.

The groundwork for implementing this project was initiated in 1996 with a combination program of mating disruption and azinphosmethyl use to reduce existing population levels. Based on this experience, no supplemental insecticide was applied in orchards with low population levels. Based on trap catches, orchards with high codling moth populations received supplemental sprays.

Program efficacy was determined by fruit evaluations twice during the growing season (preceding 2nd application of pheromone, and at harvests). Forty eight sites were selected within the project based on approximately 20 acres per site. Depending on the site layout, 1000 to 2000 fruit per site (10 per tree from top and bottom) were selected from each site and scored for fruit injury from both codling moth and potential secondary pests. Five percent of the fruit was cut to look for cryptic infestations. Bin samples were performed at harvest. We recorded damage made by codling moth, leafrollers, stink bug/boxelder bug, and Lygus.

Weekly monitoring for codling moth relied on pheromone traps baited with 10 times the normal rate of pheromone and placed high in the tree canopy. Pheromones trap were placed throughout the project at a rate of 3 traps per 10 acres. Extra traps were placed at the borders of the project baited with a 1 mg codlemone lure.

A post harvest evaluation to determine the number of fruit remaining and the percent infestation was made three weeks after harvest. Thirty-seven blocks were sampled. Infestation levels post-harvest give an indication of the population levels for the coming spring. Thus, it provides an early indication of the problem blocks in the

following year and an indication of the effectiveness of the program. Five hundred fruit per site were cut open and examined for presence of codling moth damage. Population levels at harvest will be correlated with trap catches the following year.

Results and Discussion

The area under mating disruption remained approximately the same as last year at a total of 1030 acres (see Table 1A). Organophosphate use for codling moth control was reduced by 88% assuming three cover sprays, the average number of cover sprays on orchards under organophosphate control in the Ukiah Valley in 1991 through 1995. Of the 1030 acres under pheromone confusion, 74% (762 acres) received no cover sprays, 18% (186 acres) received 1 cover spray, 7% (70 acres) received two cover sprays and 1% (10 acres) received 3 cover sprays (see Table 1C). A first cover spray was applied where traps baited with 10X lures exceeded 10 moths/trap/week. Spays were applied only in areas where there was a consistent trap catch. In this fifth year we exceeded the target of 75% reduction based on other areawide (see Table 1D).

In the year 2000 we saw a substantial increase in codling moth populations (see Table 2), with 5 orchards having unacceptable levels. Preliminary studies in a replicated side by side comparison of orchards under Isomate C+ versus Checkmate showed that trap suppression was twice as high in the orchard under Isomate C+. It is unclear if the increase in populations we experienced during the 2000 season was due to the shift in dispenser brands. The increase in populations may also be attributed to not having used any OP for two and in some cases three years. But since the decision to not spray was based on threshold levels developed under Isomate C+, it is possible that orchard under checkmate require lower threshold levels. Thus orchards were not sprayed when they should have been due to the shift in dispenser product. Total trap catches decreased from 1996 to 1997. In 1998 we observed an increase in the total trap catches due to high populations in the new acreage entering the project that year (350 acres of 900, see Farm 8 and 9 Table 2). Trap catches for the entire project decreased again during 1999 as compared to 1998.

We detected codling moth damage in only one block when fruit was sampled after the first codling moth generation. There was a substantial increase in codling moth damage as compared with previous years with 50 % of the acreage with damage at harvest that ranged from 0.1 to 0.9 % and 9% of the acreage with higher than 1% damage.

Low levels of oblique-banded leafroller infestation (0.1 to 1.5%) were detected in 96% of the acreage. This is an increase from 1996 when no damage was detected; 1997 when one block had 1% infestation; 1998 when 32% of the blocks sampled had less than 1% infestation and 9% of the blocks had between 1 and 5% damage; and 1999 when 48% of the blocks sampled had between 0.1-3.2% damage. As in previous years Boxelder damage was restricted to the first 10 rows from the riparian area. The greatest damage was observed in the rows adjacent to the Russian River with up to 2.1% damage.

Of the 37 blocks sampled post-harvest, 11 blocks (30%) had no codling moth

infestation. Eight blocks (22%) had less than 1% infestation, seventeen blocks (46%) had between 1 to 10% infestation and one block had 27% infestation. Infestation levels post-harvest give an indication of the population levels for the coming spring. It provides an early indication of the problem blocks in the coming year and an indication of the effectiveness of the program. Percent infestation less than 1% is not of concern, greater than 5% is of concern and between 1 and 5% should be monitored carefully in the coming year. Population levels at harvest will be correlated with trap catches the following year.

Table 1 - Mendocino areawide pheromone mating disruption project description (1996-2000)

A) Acres under codling moth mating disruption

	1996	1997	1998	1999	2000
Acres	400	550	900	1050	1030

B) Pheromone dispensers applied

	Ties/acre				
	1996	1997	1998	1999/2000	
	Isomate-C+	Isomate-C+	Isomate-C+	Isomate-C+[2]	Checkmate[3]
At biofix	400	400	400	400	160
At 900 dd	400	200	200[1]		160

[1] In 550 acres (350 acres received only one application at biofix)
[2] In 30% of the acreage (310 acres)
[3] In 70% of the acreage (740 acres)

C) Supplemental organophosphate cover sprays

	% Total acreage (No. acres)									
	1996		1997		1998		1999		2000	
No spray			66	(360)	61	(552)	73	(770)	74	(762)
1 spray	70	(282)	16	(90)	22	(196)	26	(270)	18	(186)
2 sprays	17	(68)	18	(100)	17	(152)	1	(10)	7	(70)
3 sprays	5	(20)							1	(10)
4 sprays	8	(30)								

D) Percent Organophosphate reduction

	1996	1997	1998	1999	2000
% OP reduction	66	80	82	95	88

Table 2 - Cumulative codling moth male trap catches (1996-2000)

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9
1996	1.87	2.07	4.82	n/a	17.49	26.29	n/a	n/a	n/a
1997	1.62	4.49	3.22	n/a	13.37	10.86	16.03	n/a	n/a
1998	7.65	5.62	4.32	4.83	5.66	8.27	7.20	32.93	11.22
1999	3.88	2.20	3.09	1.86	3.06	5.74	5.23	18.80	7.33
2000	3.94	1.46	8.40	11.57	10.09	40.66	20.27	98.78	31.07

n/a = Not applicable. Farms were not in the project that year.

Table 3 – Percent acreage with codling moth, oblique-banded leafroller and true bug damage during the 2000 season harvest

Damage caused by:	% acreage (acres) affected		
	No damage	0.1 to 0.9 % damage	≥ 1 % damage
Codling moth	41 (412)	50 (509)	9 (86)
Oblique-banded leafroller	7 (73)(	89 (895)	4 (40)
True bug	1 (11)	85 (857)	14 (139)

PEAR PEST MANAGEMENT ALLIANCE PROJECT FOR THE SACRAMENTO RIVER DISTRICT 2000 Final Report

Chuck Ingels
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Cooperating Personnel

Field Assistants: Gordon Card and Dave Vaughan
UC: Dr. Steven Welter, Dr. Bob Van Steenwyk
Participating Growers: Peter den Hartog, Mark Lubich, Mark Mamboise, Gary Martinez, Malcolm McCormack, Ed McDowell, Beth Robbins, Walt Silva, Judy Smith, Jeff Tranum, Topper Van Loben Sels, Bruce Wilcox, Chris Wilcox
PCAs: Jim Dahlberg, Bob Castanho, and Thom Wiseman, Harvey Lyman Company, Walnut Grove; Duncan Smith, Western Farm Service, Walnut Grove; Karl Yuki, John Taylor Fertilizers, Elk Grove

Background

The mating disruption practices used in the Pear Pest Management Alliance (PMA) Project in the Sacramento River District are based on methods developed during the period 1993-98 in the Randall Island Project. The primary strategy in this district is to apply pheromone dispensers at the rate prescribed by the manufacturers shortly after the first codling moth (CM) biofix, in combination with reduced applications of organophosphate (OP) insecticides - usually a single application. The goal of the 1999-2000 Pear PMA project in this district was to aid and educate growers who had not yet used mating disruption (MD) in the transition to this program.

Methods

Implementation of mating disruption. Program implementation is similar to that of the Randall Island Project. A total of 13 growers participated in the program and all these growers used mating disruption; five of these growers began using mating disruption in 1999 and eight began in 2000. Twelve of the growers used BioControl's Isomate C+ dispensers at a rate of 400 per acre and one grower used Consep's Checkmate dispensers at a rate of 200 per acre. All dispensers are placed in top third of the tree. An OP insecticide spray was applied at either the "A" or "B" peak of the first codling moth generation.

In four of the orchards in which mating disruption was used in 1999, we established blocks of about 1 to 2 acres in which the growers did not apply Agri-Mek in 2000. Research and grower experience have shown that after about a year of reduced OP usage, beneficial insects are more effective at controlling mites and psylla. We closely monitored these blocks for pest outbreaks.

In addition to the 13 participating growers noted above, at Ryde Hotel we hung Isomate dispensers (purchased by the hotel) using 400 per acre on the intermittent trees, but no insecticides were applied.

The blocks used in this study ranged in size from about 10 to 30 acres, with most in the 20 to 30 acre range. In all cases dispensers were applied at the prescribed rates throughout the entire orchard.

Monitoring of key insects. Codling moth and obliquebanded leafroller (OBLR) populations were monitored using three clusters of traps in each orchard. Each cluster had four traps: one wing trap for each CM lure type (1, 5, and 10 mg) and one for OBLR. Traps with 10 mg lures were used as the primary means of evaluating the codling moth populations. Traps with 1 mg and 5mg lures were used to help determine if the rate of pheromone release from the ties used in the mating disruption declined during the season, such that moths could identify the lower strength lures. OBLR moths were monitored using wing traps with standard lures. A total of 35 sets of traps were placed in the 14 orchards. All traps were hung in the top 2 ft. of the tree, except 1 mg CM traps, which were placed at eye level. Traps were spaced about 100 ft. apart within each cluster of traps and each trap was placed at least 3 ft. from pheromone ties.

The traps were placed at edge and interior portions of the orchard with consideration given to high-pressure areas as previously noted by the grower or the PCA. Nineteen of the trap sites were considered to be edge sites (traps placed within four rows of the orchard edge) with the remaining twelve sites considered interior sites.

The timing for the placement of the traps in the orchards was:

- 1mg traps were set March 8 - 13 in order to detect emergence of over-wintering adults.
- 5mg and 10 mg traps were set April during the first 2 weeks of April, shortly after pheromone ties were hung.
- OBLR traps were placed in mid April.

The lures were replaced according to the following schedule: 1mg (Long-Life) every 10 weeks; 5mg lures every 2 weeks; and 10mg lures (Megalures) every 12 weeks. CM and OBLR traps were monitored weekly from date of placement to July 31 and then twice more before traps were removed on August 21. Weekly monitoring updates were sent to all participating growers and PCAs.

European red mites and pear psylla were monitored several times during the season. In each orchard, 100 leaves from topshoots were examined every 3 weeks from June through early August. On the same schedule, 50 leaves from topshoots and 50 from eye level were brought back to the lab and brushed with a mite brushing machine and examined under a dissecting scope.

Fruit sampling was done during the first week of June at about 1,000 degree-days. A total of 1,000 fruit per orchard were examined (500 each from upper and lower parts of trees) for

evidence of damage by codling moth, leafrollers and green fruitworm. In addition, a further 1,000 fruit per orchard were examined in bins during each harvest.

Meetings and Updates. Weekly updates of trap counts and visual inspections were faxed or mailed to participating growers and PCAs. We held a meeting in March 2000 to share with growers and PCAs information related to the mating disruption program. Invited speakers were Lucia Varela, North Coast IPM Advisor, who discussed the experiences of Mendocino growers with mating disruption; Dr. Robert Van Steenwyk, UC Berkeley Entomology Specialist, who discussed possible spray programs in mating disrupted orchards; and Chuck Ingels, UC Cooperative Extension Farm Advisor, who discussed economics of mating disruption strategies and methods for hanging pheromone ties.

A meeting of growers and pest control advisers was also held in October 2000 to discuss the results of the 2000 season and plans for 2001.

Results

Pheromone and OP Insecticide Usage. Nearly all growers used Isomate C+ dispensers at 400 per acre (Table 1). One grower used CheckMate dispensers at 200 per acre. All of the growers used only one OP application (Table 1). Three of the growers applied Imidan 70-W at the 1A flight, a further nine growers applied Imidan 70-W at the 1B flight and just one grower used Guthion. Imidan was used mainly because of the 14-day restricted entry interval for Guthion. Applying Guthion would have prevented fire blight cutting during this severe fire blight year; the REI was reduced to 48 hrs. in early summer.

Trap Catches and Fruit Damage. The 10mg trap counts indicated an extremely low population in each of the participating grower's orchards (Fig. 1); the counts were somewhat higher at Ryde Hotel. The 5 mg traps caught more moths than the 10 mg (Megalure) traps. Additional research in 2000 showed that Megalure lures catch less than half the number of moths as standard lures. Regardless, 1 mg traps caught almost no moths the entire season; this is the most important finding because it shows that mating disruption is working.

In our June fruit inspections, we found no codling moth damage and only 3 fruit with old green fruitworm damage. Codling moth damage was zero at both harvests in all orchards (Table 2). Despite a few orchards having high OBLR trap catches, fruit damage was generally low. Only two orchards had fairly substantial OLBR damage. A small amount of codling moth damage was found during the early June fruit examination at the Ryde Hotel. The fruit at the Ryde Hotel was not harvested and was not inspected during the harvest period.

Pear psylla and European red mites were near zero through most of the spring and summer. In mid-August we found only 4 psylla nymphs on one topshoot in one orchard in which Agri-Mek was not applied. At the same time, we found European red mites (0.3/leaf) in only one orchard. However, we found twospotted spider mites in two non-Agri-Mek orchards (0.3 and 0.7/leaf) and two orchards in which Agri-Mek was applied (0.2 and 0.6/leaf). In three of the non-Agri-Mek orchards, we also found about 0.1 to 0.2 predatory mites per leaf but far fewer in other orchards.

Mite buildups late in the season are less of a concern than before harvest because of the pre-harvest interval; also, late season mites can usually be taken care of with the dormant oil and delayed dormant Asana applications. It is also encouraging that predatory mites were found.

Table 1. Pheromone and Insecticide Usage for CM and OBLR

Grower	Mating Disruption			CM/OBLR Insecticide		
	Product	**Date of Hanging**	**Rate** *(ties/A)*	**Product**	**Date of Applic.**	**Rate** *(lbs./A)*
Peter den Hartog - Thornton	Isomate C+	April 6	400	Imidan	June 5	5
Mark Lubich - Cal Bart Orchards	Isomate C+	March 31	400	Guthion	June 3	3
Mark Mamboise - Reid Ranch	Isomate C+	March 24	400	Imidan	May 31	5
Gary Martinez - Pacific Fruit Farms	Isomate C+	April 7	400	Imidan	May 30	5
Malcolm McCormack - Koket Collins	Isomate C+	March 31	400	Imidan	June 3	5
Ed McDowell - McDowell Farms	Isomate C+	April 14	400	Imidan	May 6	6
Beth Robbins - Brown & Kahrs	Isomate C+	April 15	400	Imidan	May 6	6
Walt Silva - Courtland	Isomate C+	March 31	400	Imidan	June 1	5
Judy Smith - Smith Ranch	Checkmate	April 5	200	Imidan	June 1	4
Jeff Tranum - Runyon Ranch	Isomate C+	April 2	400	Imidan	June 6	5
Topper Van Loben Sels - Poldar ranch	Isomate C+	April 10	400	Imidan	June 7	5
Bruce Wilcox - Shop Ranch	Isomate C+	April 21	400	Imidan	May 5	6
Chris Wilcox - Grand Is. Road	Isomate C+	April 5	400	Imidan	May 28	4

Figure 1. Average Number of Codling Moths per Trap, 2000
(All PMA Growers)

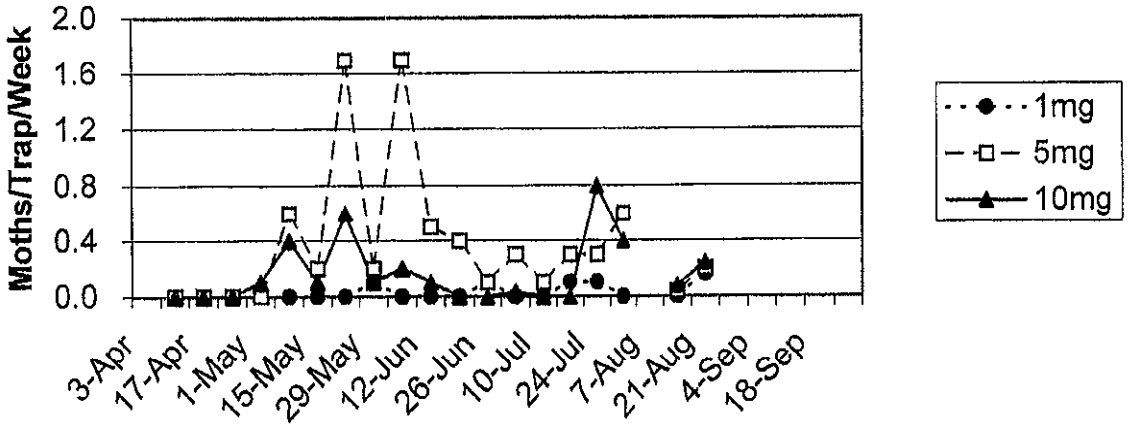

Figure 2. Average Number of OBLR Moths per Trap, 2000
(All PMA Growers)

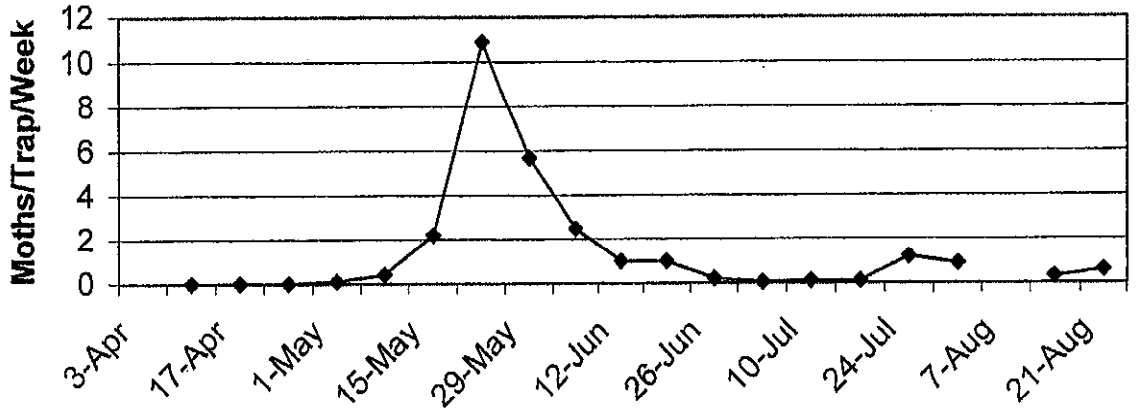

Table 2. Fruit Evaluations at Harvest

		No. of Damaged Fruit/1000					
		First Harvest			Second Harvest		
Grower	Orchard/Farm	CM	GFW	OBLR	CM	GFW	OBLR
den Hartog	Thornton	0	0	0	0	0	1
Lubich	Cal Bart	1	0	0	3	0	0
Mamboisse	Reid Ranch	One harvest			0	0	0
Martinez	Pacific Fruit Farms	0	0	1	0	0	24
M. McCormack	Koket-Collins	Missed			0	0	0
McDowell	McDowell Farms	0	0	0	0	0	0
Robbins	Brown & Kahrs	One harvest			0	0	0
Silva	Courtland	0	2	2	Field sorted		
Smith	Smith Ranch	0	0	0	Field sorted		
Tranum	Runyon	0	2	1	0	1	0
Van Loben Sels	Poldar	0	4	0	0	3	6
B. Wilcox	WG Shop	0	0	0	0	0	0
C. Wilcox	Grand Island	Missed			0	0	0

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El Dorado County
Pear Pest Management Alliance
2000 Final Report

Randy Hansen, Pest Control Advisor, Weddle, Hansen & Associates, Inc., Placerville
Chuck Ingels, Farm Advisor, UC Cooperative Extension, Sacramento County

Participating Growers: Pat O'Halloran, Byron Sher and Tom Heflin

Abstract

In this project, three growers used Codling Moth mating disruption (MD). Two growers first used MD in 1999 and one grower began this season. (A third grower participated in 1999. That block was removed between seasons).

In 1999, sprays were modestly reduced in the two participating blocks. The goal was to reduce them further in this second season. That goal was met as those blocks were treated one time each with an OP.

The first year block had a very high codling moth (CM) population. In 1999, this block was unsprayed and unharvested due to extensive hail damage. In 2000, MD combined with 3 OP sprays brought CM damage down to a level where the crop could be harvested.

Background

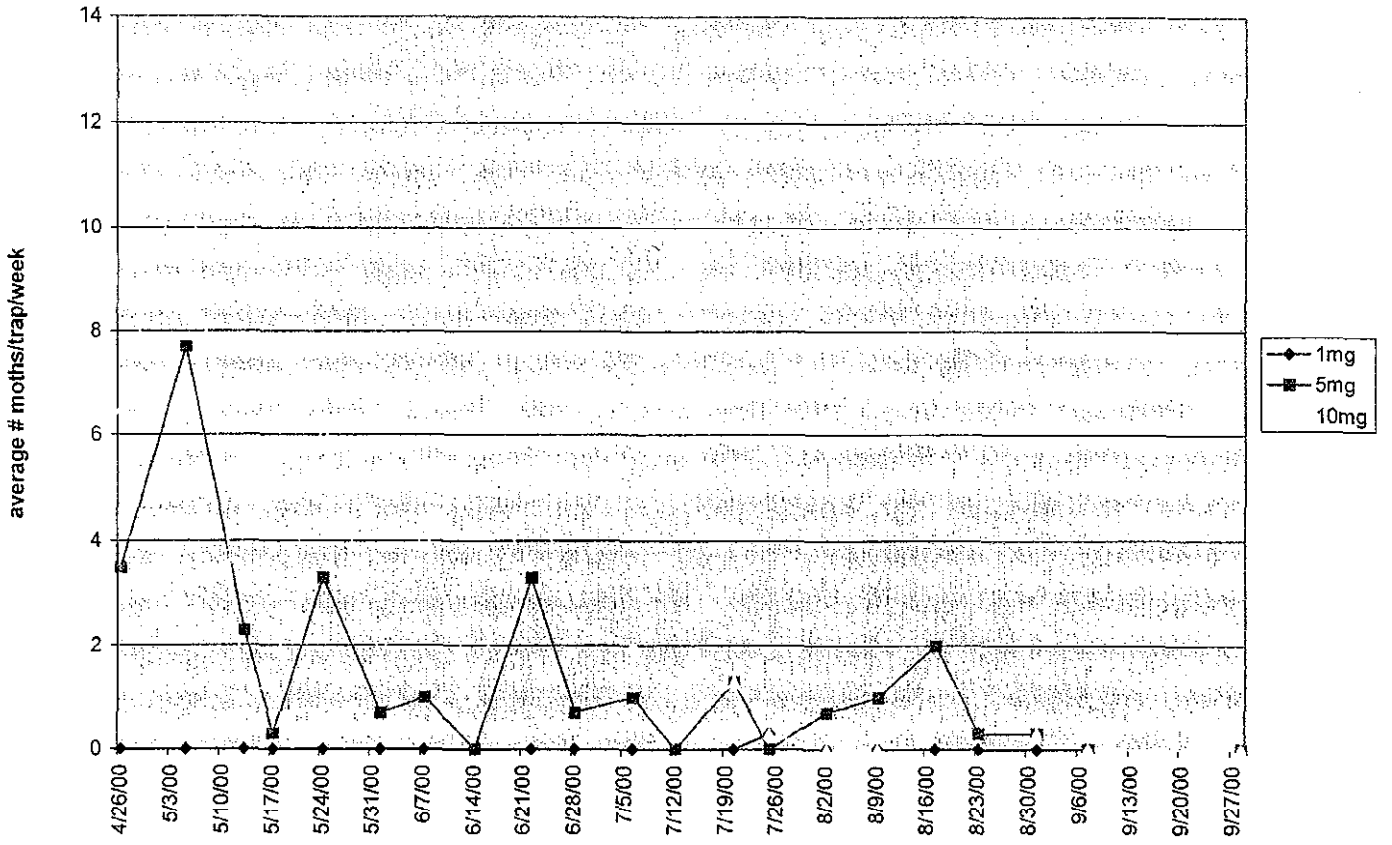
Most pear orchards in El Dorado County are smaller than in other pear districts. All of these factors make it more difficult for MD to be as successful as in other situations.

The following pests were monitored in much the same way as in the Sacramento Pest Alliance project: CM, OBLR and other worms, European red mite, 2-spotted spider mite, pear psylla as well as predators of these pests. Weekly updates were sent to all growers.

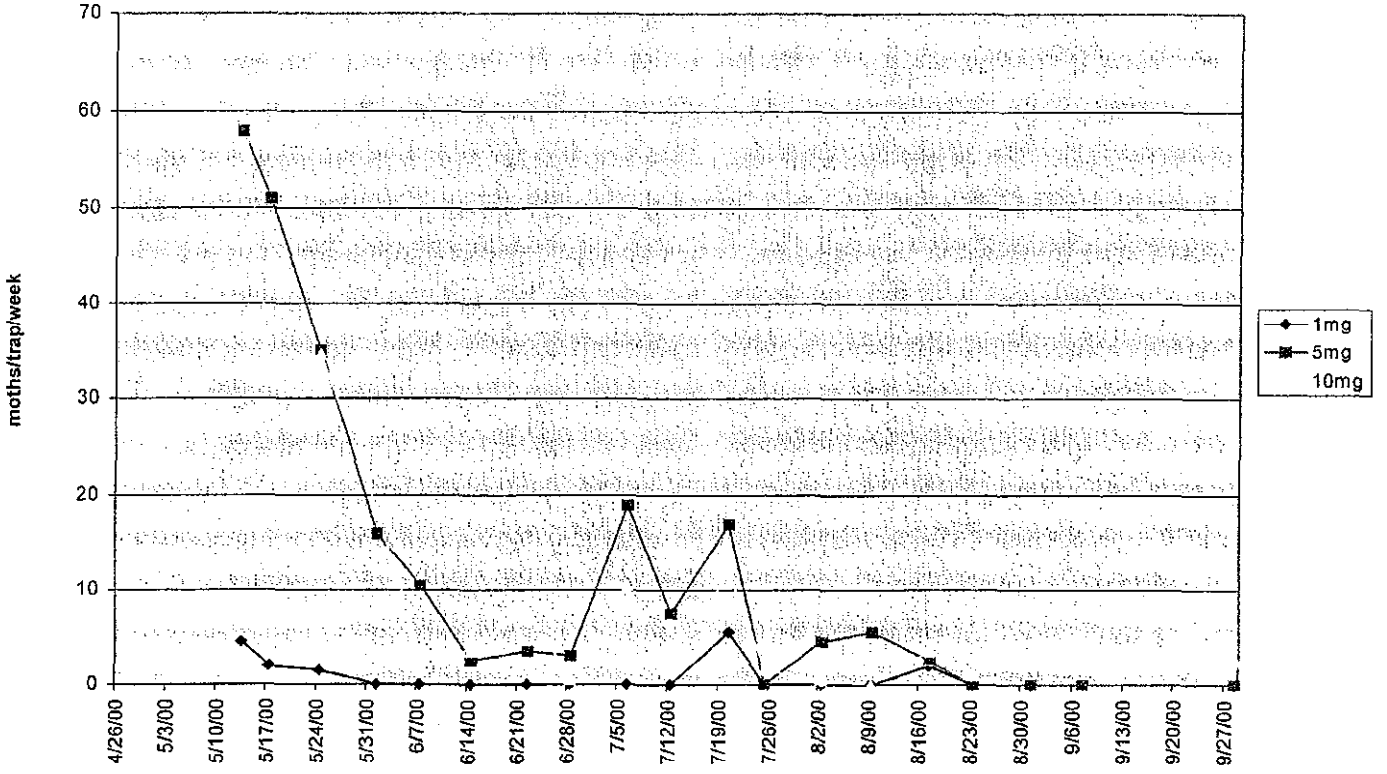
Results

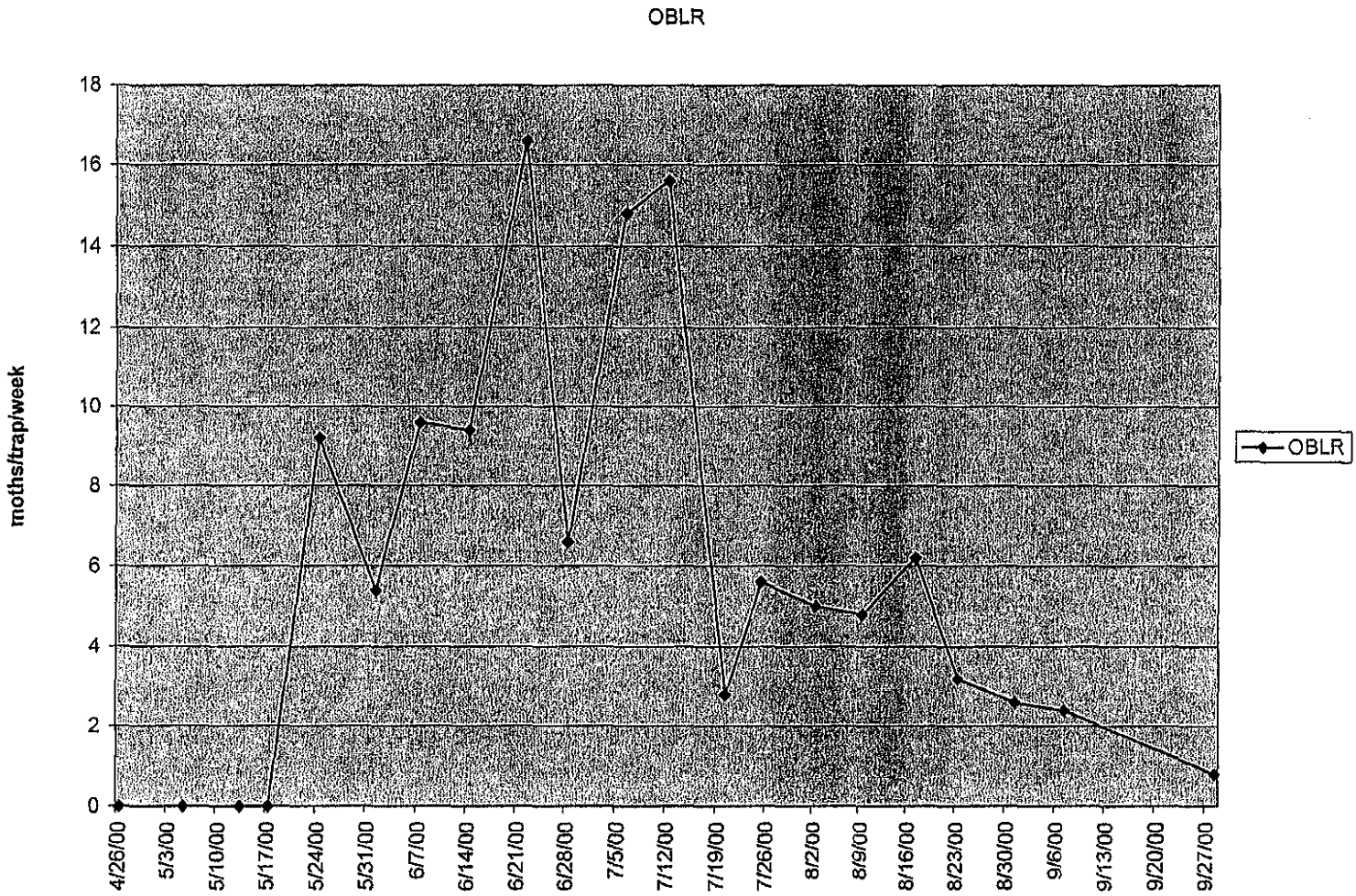
Codling Moth trap data is charted separately below for the second and first year MD blocks since population sizes were so different. The two second-year blocks were treated one time each for CM (plus a border spray in one block). No CM damage was seen in harvest samples. In the first year block, 3 OP sprays were applied. (Non-MD blocks in the area are typically treated 3-4X with OPs). CM damage first appeared in late June and reached approximately 5% at harvest in mid August. Psylla and mite populations remained low in all blocks before and through harvest.

Average # Codling Moth/Trap (second year blocks)



Average # Codling Moth/Trap (first year block)




OBLR
moths/trap/week
18
16
14
12
10
8
6
4
2
0
4/26/00
5/3/00
5/10/00
5/17/00
5/24/00
5/31/00
6/7/00
6/14/00
6/21/00
6/28/00
7/5/00
7/12/00
7/19/00
7/26/00
8/2/00
8/9/00
8/16/00
8/23/00
8/30/00
9/6/00
9/13/00
9/20/00
9/27/00
OBLR

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SUISUN VALLEY
Pear Pest Management Alliance
2000 Final Report

Randy Hansen, Pest Control Advisor, Weddle, Hansen & Associates, Inc., Placerville
Chuck Ingels, Farm Advisor, UC Cooperative Extension, Sacramento County
Wilbur Reil, Farm Advisor, UC Cooperative Extension, Solano County
Participating Growers: Larry Glashoff, Sue Lipstreau, Ray Erickson, Lupe Rodriguez, Henry Maeyama

Abstract

In this project, five growers (seven total orchards) used Codling Moth mating disruption (MD). Three of these growers had used MD for one season in 1994 but had abandoned it due to cost and poor crops in subsequent years. At that time, monitoring in MD blocks was less well developed.

Codling Moth (CM) populations in these blocks were relatively high in 1999. In four of the seven blocks, sprays were substantially reduced while the higher populations in the other three blocks only allowed for slightly reduced treatments in this first season. One additional grower began the season as part of this project, but the orchard was abandoned partway through the season due to extensive hail damage.

Background

Most pear orchards in the Suisun district are smaller than in other pear districts. The district is known for windy conditions. (Suisun means "west wind" in the local indigenous tongue.) The trees are trained in a very open style and are widely spaced in the typical orchard. All of these factors make it more difficult for MD to be as successful as in other situations.

The following pests were monitored in much the same way as in the Sacramento Pest Alliance project: CM, OBLR and other worms, European red mite, 2-spotted spider mite, pear psylla as well as predators of these pests. Weekly updates were sent to all growers.

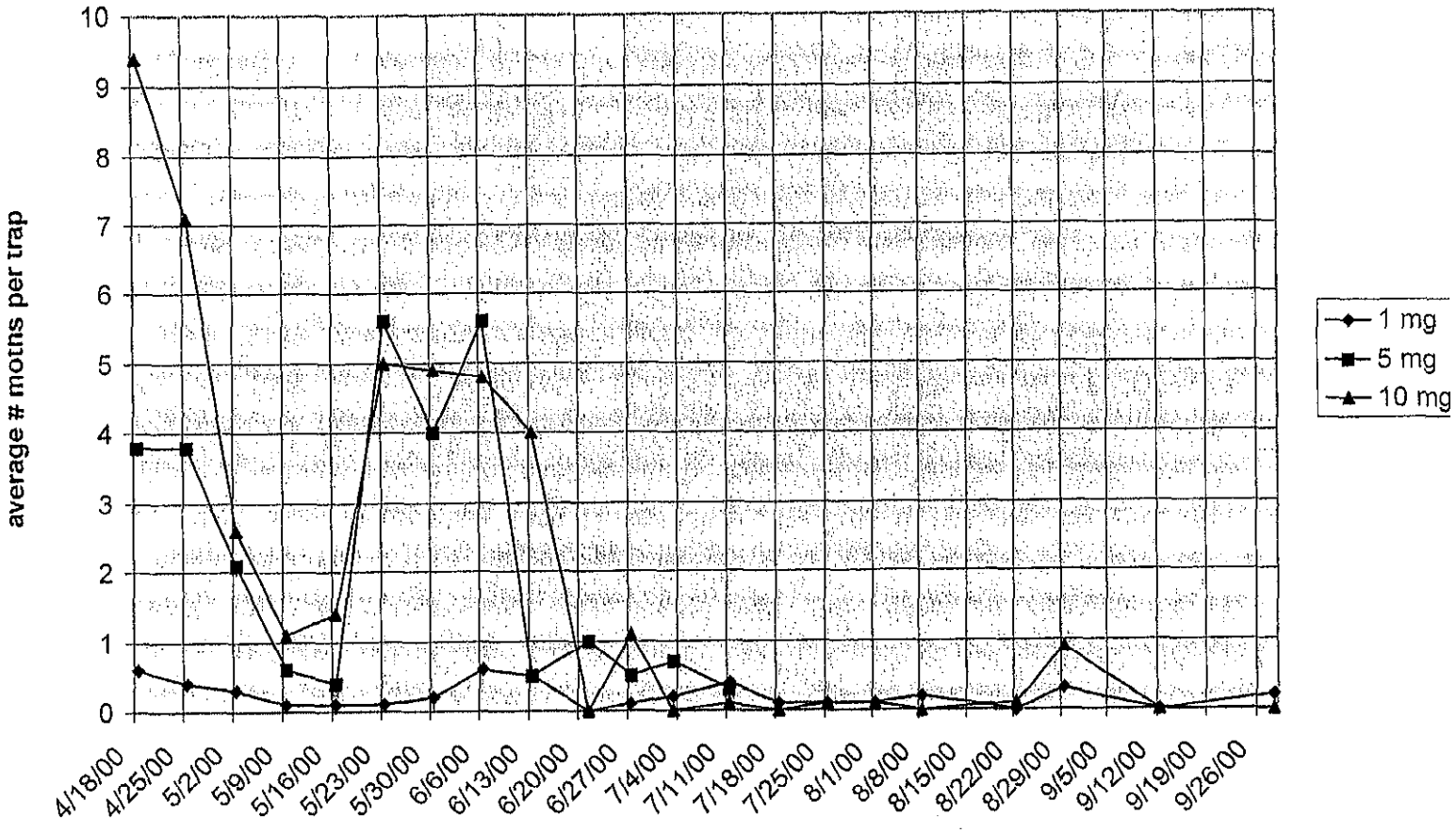
Results

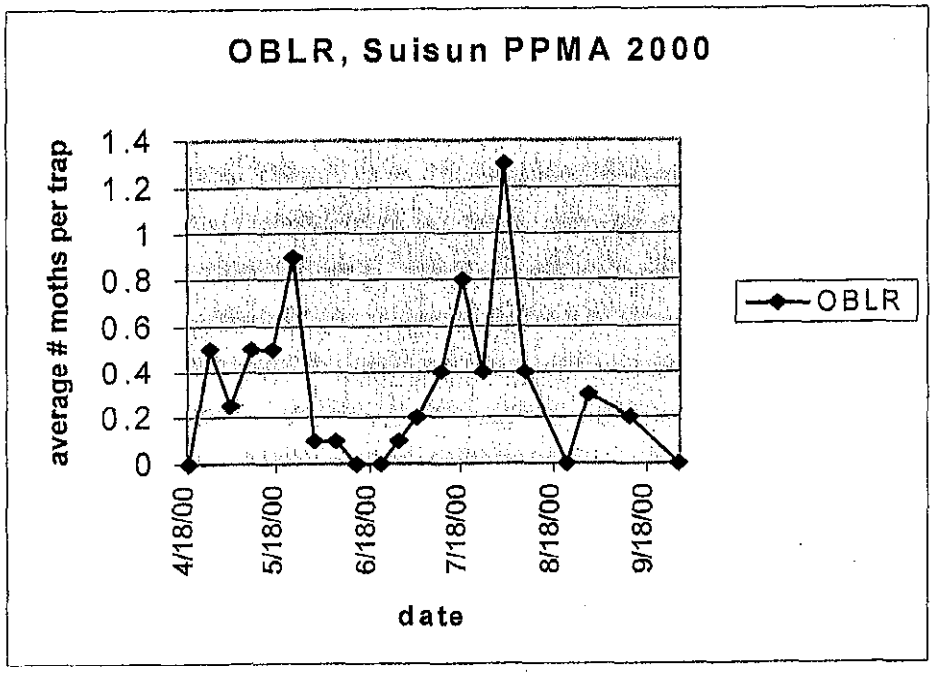
Codling Moth Trap catches were very high the first 1-2 weeks after placing MD dispensers in the orchards. Catches in 5&10mg traps were nearly the same. 5mg traps were discontinued in early July. Blocks using Checkmate did had higher trap catches than the adjacent block using Isomate.

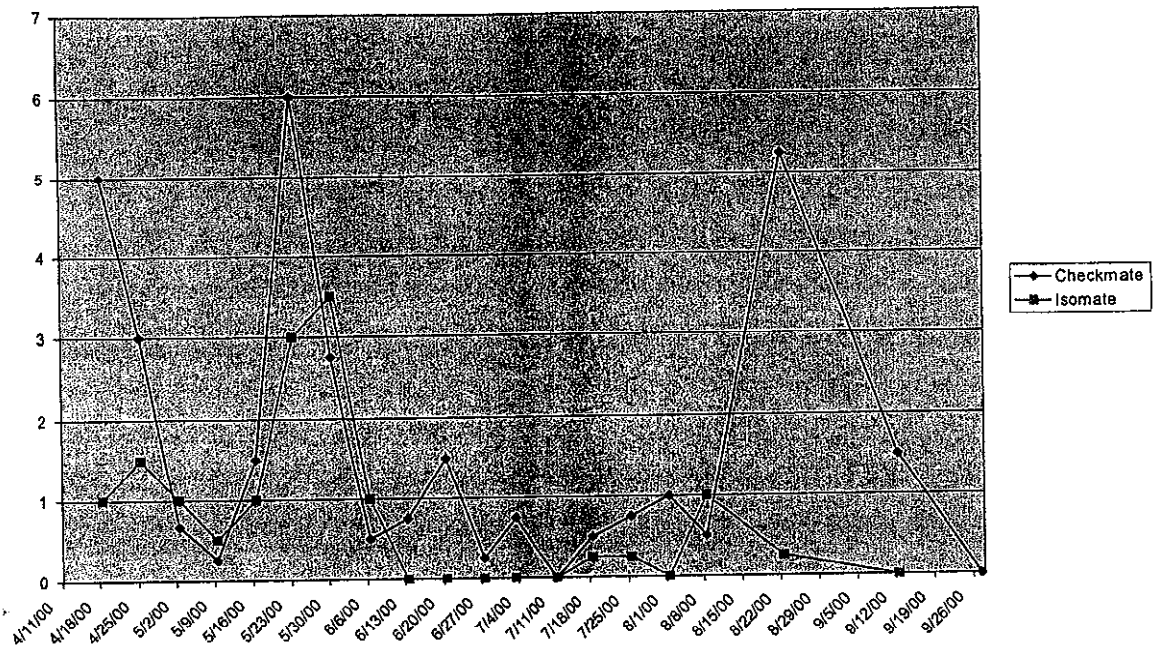
OBLR Traps were very low all season. Two distinct flights are still apparent. One orchard had a seasonal total of 35 in one trap (a one-week high catch of 8). The remaining blocks had seasonal totals of 0-5. No OBLR damage was seen, although hail damage in some blocks made assessment difficult. Fruit tree leafroller adults were heavily trapped in many OBLR traps in May. One block was treated for FTLR in early April.

OP Insecticide Usage In this district, 3-4 OP sprays per season is standard in non-MD orchards. All participating blocks had OP sprays reduced relative to previous seasons without MD. In the MD blocks, 3 growers reduced spraying to 2X (+ one in one of the Checkmate blocks), 1 grower used 3 including a spray for Fruit tree leafroller prior to CM timing and in the remaining three orchards, 3 sprays were directed at CM.

Codling Moth Suisun PPMA 2000







PHEROMONE & INSECTICIDE USE for CODLING MOTH & LEAFROLLERS

CM & Leafroller Insecticide Treatments

GROWER/ BLOCK	Dispenser Hanging Date	PRODUCT	DATE	RATE (lbs/ac)
Erickson – Isomate	4/10	Guthion Imidan	5/27 7/15	2 5
Erickson – Checkmate	4/10	Guthion Imidan Imidan	4/27 5/29 7/15	2 5 5
Maeyama Checkmate & Isomate blocks	4/10	Guthion Guthion	5/31 7/17	1.5 1.5
Glashoff Chadbourne	3/28	Guthion (borders only) Guthion Imidan	5/2 5/29 7/21	2.5 (borders only) 2.5 5
Lipstreau Grotheer	4/2	Diazinon Imidan Guthion	4/12 4/26 5/26	2.5 5 3
Rodriguez Home	4/10	Guthion Guthion Imidan	6/3 6/28 7/17	3 2.5 5
Rodriguez Wylie	4/4	Guthion Guthion Imidan	6/7 6/30 7/22	3 2.5 5
Rodriguez Gum	4/10	Guthion Guthion Imidan	6/10 7/1 7/18	3 2.5 5

Evaluation of New Insecticides for True Bug Control

R. A. Van Steenwyk, L. G. Varela & S.C. Welter

Abstract: True bugs were not considered to be major pear pests in the past. However, recent changes in the codling moth (CM) management have resulted in increased damage by true bugs. True bugs are often controlled indirectly by organophosphate (OP) insecticides that are applied for CM control. The pheromone mating disruption programs for CM has successfully suppressed CM, consequently, OP use was reduced by about 75%. Unfortunately, the reduced usage of OP insecticides resulted in a substantial increase in true bug. If outbreaks of true bugs occur in mating disrupted orchards and require OP or carbamate insecticide applications for their control, then the value of the IPM program that reduces OP insecticides use will be threatened. New true bug insecticides, which are effective, environmentally benign, biologically selective and exhibit low mammalian toxicity must be found and registered in order to reap the ecological benefits of the pheromone based CM management strategy.

From the 1999 studies, a number of insecticides were evaluated both in the laboratory and field for true bug control. The pyrethroid insecticides (Asana, Danitol) provided control over an extended period of time when the true bugs were caged for 12 hours on treated foliage. However, their use would be very disruptive to the pear ecosystem. The most promising new insecticide for true bug control is Provado. Provado is a nicotinoid insecticide and is registered for use on pears. It was found that to evaluate the nicotinoid insecticides the true bugs needed to be caged on treated foliage for greater than 12 hours. It was also found that the plastic zip-lock bag method of bioassay greatly underestimates the mortality of the pyrethroid and nicotinoid insecticides. Other methods of bioassay must be found for laboratory comparisons.

From the 2000 studies, a number of insecticides were evaluated both in the laboratory and field for Lygus bug (LB) control. The pyrethroid insecticides (Asana, Danitol, Baythroid, Brigade and Decis) provided exceptional control over an extended period of time when the true bugs were caged for 24 hours on treated foliage. Again, the use of pyrethroid insecticides would be very disruptive to the pear ecosystem. Field evaluations of the nicotinoid insecticides (Assail, Actara, Provado, Calypso, V-10066) provided very promising results. Provado and Actara were as efficacious as Dimethoate or Carzol and V-10066 was nearly as efficacious as the pyrethroid insecticides. It was found that foliage laboratory bioassay method provides the potential to better mimic the field efficacy of pyrethroid and nicotinoid insecticides.

Introduction: True bugs [*Lygus hesperus* Knight (western tarnished plant bug), *L. elisus* Van Duzee (pale legume plant bug), *Euschistus conspersus* (consperse stink bug), *Thyanta custator* McAtee (redshouldered stink bug), *Acrosternum hilare* Say (green stink bug), *Boisea trivittata* Say (boxelder bug) and others] have not historically been considered as major pests in pears. However, recent changes in the CM management strategy have resulted in increased damage by true bugs. True bugs do not develop in pears and nymphs are seldom found on pear trees. However, adults migrate from neighboring areas and orchard weeds to feed on developing fruit.

Adult feeding can cause lesions or dimples on the fruit. This feeding makes the pears unmarketable for either fresh market or cannery sale. True bugs had been controlled indirectly by organophosphate (OP) insecticides that are applied for codling moth (CM) control. The pheromone mating disruption programs for CM have significantly reduced the use of OP insecticides. Unfortunately, the reduced use of OP insecticides has resulted in a substantial increase in true bug damage. In some orchards using pheromone control for CM, damage was greater from the true bugs than from CM. If outbreaks of true bugs occur in mating disrupted orchards and require OP insecticides for their control, then the value reduce OP use will be lost. In addition, the implementation of the Food Quality Protection Act of 1996 may result in greatly extended pre-harvest intervals or terminate of registrations of many OP insecticides.

New true bug insecticides that are effective, environmentally benign, biologically selective, and exhibit low mammalian toxicity must be found and registered in the near future in order to reap the ecological benefits of the pheromone based CM management strategy. Reported here are the results of our laboratory and field insecticide evaluations on true bugs for both 1999 and 2000. The 1999 data is included here because it was inadvertently not included in the 1999 report.

Field Evaluations of Insecticides for True Bug Control in Pears - 1999

Methods and Materials: Two trials were conducted on mature 'Bartlett' pear trees in a commercial orchard near Hood, CA. Trial A consisted of five treatments and trial B consisted of eight treatments. Each treatment was replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction from the treated tree. Treatments were applied between 6:00 a.m. to 9:00 a.m. on 7 June for trial A and 12 July for trial B with a hand-held orchard sprayer operating at 200 psi and delivering 400 gal/acre of finished spray (1.33 gal/tree). Control in trial A was evaluated by caging 20 adult lygus bugs (LB) on the foliage for 12 hours (6:00 p.m. to 6:00 a.m.) at 0, 3, 7 and 14 days after treatment (DAT). Control in trial B was evaluated by caging 20 adult LB and 20 adult green stink bugs (GSB) in separate cages for each treatment on the foliage for 12 hours (6:00 p.m. to 6:00 a.m.) at 0, 3, 7 and 14 DAT.

Results and Discussion: All insecticide treatments in both trials resulted in significant true bug mortality compared to the untreated control at 0 DAT (Table 1). In trial A, Asana and Provado and in trial B, Danitol, both rates of Asana, and the two high rates of Provado provided excellent LB control while only Danitol and Asana provided excellent GSB control. At 3 DAT in trial A, all insecticide treatments provided significantly greater LB mortality as compared to the untreated control. In trial B, Danitol, both rates of Asana and the high rate of Provado provided significantly greater LB mortality compared to the untreated control with only the high rate of Asana providing excellent LB control. Danitol and Asana provided significant control of GSB but neither provided excellent control. Similar results were observed at 7 DAT, however, no treatment resulted in excellent control. At 14 DAT in trial B, mortality was greatly increased as compared to 7 DAT. Both rates of Asana for LB and Danitol for GSB provided greatly improved control. This increase in mortality was likely the result of higher temperatures over that period. The maximum air temperature at 7 DAT was 75°F in trial B while the maximum air temperature

at 14 DAT was 85°F. An increase in temperature appears to greatly increase the mortality of true bugs by both Asana and Danitol.

Table 1. Mean Percent Mortality of Caged Lygus and Green Stink Bugs at Hood, CA - 1999

		Mean[a] Percent Mortality DAT							
	Rate	0		3		7		14	
Treatment	lb. (AI)/ac	LB	GSB	LB	GSB	LB	GSB	LB	GSB
					Trial A				
1. Dimethoate E267	2.000	59 c	----	50 b	----	19 b	----	16 a	----
2. Asana XL	0.072	80 d	----	89 c	----	45 c	----	76 b	----
3. Provado 1.6F	0.250	74 d	----	54 b	----	40 c	----	23 a	----
4. Actara 25 WG	0.063	50 b	----	46 b	----	23 bc	----	18 a	----
5. Untreated	----	17 a	----	17 a	----	5 a	----	15 a	----
					Trial B				
1. Alert 2SC	0.313	59 c	----	23ab	----	13 a	----	43 ab	----
2. Asana XL	0.041	97 e	----	35 bc	----	19 ab	----	87 cd	----
3. Asana XL	0.072	100 e	97 c	91 e	29 b	31 bc	39 bc	90 d	51 b
4. Danitol 2.4 EC	0.394	96 e	98 c	61 d	38 b	43 c	59 c	59 bc	83 b
5. Provado 1.6F	0.063	48 b	----	9 a	----	8 a	----	34 ab	----
6. Provado 1.6F	0.125	80 d	----	22 ab	----	17 ab	----	28 a	----
7. Provado 1.6F	0.250	81 d	52 b	45 cd	13 a	8 a	15 ab	36 ab	20 a
8. Untreated	——	17 a	6 a	9 a	5 a	7 a	4 a	16 a	1 a

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Conclusion: LB and GSB were confined on the foliage for only 12 hours overnight achieving a rigorous evaluation of the insecticide treatments. Confining LB for 24 hours, or more would likely increase the efficacy of the insecticides (see Evaluation of Lygus Control at Various Periods of Foliar Exposure). However, if temperatures exceeding 90°F during the day, then the high temperatures during the middle of the day would cause high control mortality. All experimental treatments provided a significantly higher mortality than the untreated control on the day of treatment. However, Alert and the lower two rates of Provado 1.6F were not significantly different than the untreated control at 3, 7 and 14 DAT. Danitol and the high rate of Asana XL were the only treatments with significantly greater mortality compared to the untreated control at every evaluation period and their effectiveness appears to be temperature dependent. The most promising new chemistry for true bug control is Provado. Research next year will concentrate on Provado and other nicotinoid insecticides that are being developed by various agricultural chemical manufacturers.

Lygus Bug Control at Various Periods of Foliar Exposure – 1999

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard near Fairfield, CA. Three treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree. Treatments were applied on 8 August between 6:00 a.m. to 9:00 a.m. with a hand-held orchard sprayer operating at 250 psi and delivering 200 gal/acre of finished spray (2.87 gal/tree). Control was evaluated by caging 20 adult LB on the foliage for 12, 24, and 48 hours starting at 6:00 p.m. on the day of treatment.

Results and Discussion: When LB were confined on the foliage for 12 hours, control was poor with either Dimethoate or Provado (Table 2). When LB were confined on the foliage for 24 hours, mortality of both Dimethoate and Provado increased without corresponding increase in the mortality in the untreated control. When the LB were confined on the foliage for 48 hours, control increased to an acceptable level with either Dimethoate or Provado. However, the mortality in the untreated control was approaching 25%, which is unacceptable. When corrected for untreated control mortality, the Dimethoate mortality increased substantially from 12 to 24 hours of confinement and then remained about the same for 48 hours of confinement while Provado mortality increased with length of time of LB confinement. Unfortunately, this study was conducted with moderate maximum air temperatures and control mortality could not be determined at high (90°F) maximum air temperatures.

Table 2. Mean Percent Mortality of Caged Lygus Bugs for Various Period After Treatment at Fairfield, CA. - 1999

		Rate	Mean[a] Percent (Corrected) Mortality Hours after Treatment					
	Treatment	lb. (AI)/ac	12		24		48	
1)	Provado 1.6F	0.075	44 ab	(32)	61 b	(52)	88 b	(85)
2)	Dimethoate	1.340	53 b	(40)	79 b	(74)	81 b	(75)
3)	Untreated	——	17 a	----	19 a	----	23 a	----

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Conclusions: LB mortality increased with the time that the bugs were confined on foliage treated with either Dimethoate or Provado. The effect was more pronounced with Provado than Dimethoate. When moderate temperatures are predicted (max. air of about 75°F), it appears that LB can be confined for 24 hours on foliage without unacceptable control mortality.

Evaluations of Pyrethroid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Fairfield, CA. Six treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction. Treatments were applied on 3 May with a hand-held orchard sprayer operating at 250 psi and delivering 250 gal/acre of finished spray volume (2.78 gal/tree). Control was evaluated by

caging 25 laboratory cultured, adult LB on the foliage for approximately 24 hours at 0, 7, 14, 21, 28, and 35 DAT.

Results and Discussion: LB were confined on the pear foliage for only 24 hours generating a rigorous evaluation of the insecticide treatments. Control of LB was excellent with all pyrethroid insecticides through 21 DAT (Table 3). LB mortality started to break down at 28 DAT for Brigade and at 35 DAT for Asana and Danitol. Control was excellent through the entire study for Decis and Baythroid. While high control mortality was observed in the untreated control, when maximum air temperatures exceeded 85°F, the corrected mortality using Abbott's formula resulted in a similar mortality trend as the uncorrected mortality (Table 4).

Table 3. Mean Percent Mortality of Caged Lygus Bugs at Fairfield, CA – 2000

Treatment/	Rate	Percent Mortality DAT					
formulation	lb. (AI)/acre	0	7	14	21	28	35
Asana XL	0.072	100.0 b	93.9 b	82.5 b	93.1 bc	86.6 bc	76.7 bc
Baythroid 2EC	0.044	100.0 b	98.0 bc	100.0 c	100.0 c	92.0 bc	94.1 c
Brigade 10WP	0.080	100.0 b	95.0 bc	88.4 b	85.3 b	69.6 b	72.2 b
Decis 0.2EC	0.033	100.0 b	100.0 c	95.0 bc	93.3 bc	97.0 c	94.7 c
Danitol 2.4EC	0.394	100.0 b	91.0 b	95.0 bc	82.8 b	90.9 bc	73.1 bc
Untreated check	----	36.2 a	31.6 a	17.7 a	29.1 a	24.4 a	20.3 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Table 4. Mean Percent Corrected Mortality of Caged Lygus Bugs at Fairfield, CA - 2000

Treatment/	Rate	% Corrected Mortality DAT					
formulation	lb. (AI)/acre	0	7	14	21	28	35
Asana XL	0.072	100.0	91.1	78.7	90.3	82.3	69.2
Baythroid 2EC	0.044	100.0	97.1	100.0	100.0	89.4	92.2
Brigade 10WP	0.080	100.0	92.7	85.9	79.3	59.8	63.2
Decis 0.2EC	0.033	100.0	100.0	93.9	90.6	96.0	93.0
Danitol 2.4EC	0.394	100.0	86.8	93.9	75.7	88.0	64.4

Conclusions: All pyrethroid insecticides tested provided excellent LB control. Decis and Baythroid provided excellent control with over 90% control through 35 DAT.

Evaluation of Nicotinoid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Fairfield, CA. Eight treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction. The insecticides were applied on 12 June with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 250 gal/acre (2.78 gal/tree). Control was evaluated by caging 25

laboratory cultured, adult LB on the foliage for approximately 24 hours at 0, 3, 7, 14, 21, and 28 DAT.

Results and Discussion: Due to high maximum temperatures, control mortality was very high particularly at 0 DAT (Table 5). In an effort to reduce control mortality, all cages were covered with aluminum heat shields at 3 DAT. The heat shields helped reduce the control mortality. To correct for the control mortality, Abbott's formula was applied to the data. The Actara and Provado insecticide treatments provided significantly greater LB mortality compared to the untreated control at each evaluation period. The Actara and Provado treatments were especially efficacious and they are promising insecticides for true bug control. Calypso provided significantly greater LB mortality compared to the untreated control at each evaluation period after the 0 DAT evaluation. Assail was less efficacious than Calypso but showed some LB activity. Calypso and Assail were applied at 0.15 lb (AI)/ac in this trial. If Calypso and Assail were applied at 0.25 lb (AI)/ac, control might have been similar to that of Provado and Actara. Although Dimethoate provided 100% mortality at 0 DAT, control rapidly diminished and was not significantly different from the untreated control by 7 DAT. Carzol showed only fair mortality at 0 DAT and was not significantly different from the untreated control by 14 DAT. Avaunt does not appear to be a promising true bug insecticide

Table 5. Mean Percent Mortality of Caged Lygus Bugs at Fairfield, CA – 2000

Treatment/	Rate	Percent Mortality DAT					
formulation	lb. (AI)/acre	0	3	7	14	21	28
Calypso 4SC	0.150	59.5 b	50.9 c	53.0 bc	49.2 c	27.2 c	38.4 bc
Assail 70WP	0.150	35.8 a	48.6 bc	37.3 ab	44.6 bc	30.6 c	30.4 abc
Actara 25WG	0.250	96.0 cd	76.1 d	87.9 e	92.0 d	67.1 d	41.2 cd
Provado 1.6F	0.250	93.8 cd	74.1 d	81.3 de	81.0 d	64.5 d	60.0 d
Dimethoate E267	2.000	100.0 d	45.7 bc	29.1 a	20.6 a	22.1 bc	23.6 a
Carzol SP	0.920	85.4 c	54.7 c	63.8 cd	30.0 ab	13.9 ab	26.1 ab
Avaunt 30WG	0.110	64.4 b	35.5 ab	42.0 ab	29.2 ab	14.8 ab	18.4 a
Untreated check	----	51.1 ab	23.3 a	25.1 a	23.0 a	6.6 a	20.9 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.

Conclusion: Actara and Provado are promising new insecticides for true bug control with an extended period of activity. They provided as high or higher mortality than grower standards of Dimethoate or Carzol. Calypso and Assail should not be discounted as potential true bug materials but should be reevaluated at higher rates of application.

Rate Evaluations of Nicotinoid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Fairfield, CA. Nine treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction.

The insecticides were applied on 14 August with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 250 gal/acre (3.57 gal/tree). Control was evaluated by caging 25 laboratory cultured, adult LB on the foliage for approximately 24 hours at 0, 3, 7, 14, 21, and 28 DAT. Heat shields were used over the caged LB to reduce control mortality.

Results and Discussion: All the treatments provided significantly higher mortality compared to the untreated control at 0, 3, and 7 DAT except Dimethoate (Table 6). Dimethoate was not significantly different from the untreated control at 7 DAT and evaluations of Dimethoate were terminated at 21 DAT. Both Actara and Provado showed a rate response with Actara slightly outperforming Provado. V-10066 is a very promising new nicotinoid insecticide that gave significantly higher mortality compared to the untreated control throughout the study.

Conclusion: All nicotinoid insecticides provided excellent LB control for an extended period of time. V-10066 and the higher rate of Actara and Provado were especially efficacious. V-10066 was effective through 28 DAT.

Table 6. Mean Percent Mortality of Caged Lygus Bugs at Fairfield, CA. - 2000

Treatment/	Rate	Percent Mortality DAT					
Formulation	lb. (AI)/acre	0	3	7	14	21	28
Provado 1.6F	0.063	96.0 cd	88.0 cd	52.7 b	17.7 a	16.3 a	19.6 a
Provado 1.6F	0.125	98.1 de	96.0 ef	67.6 b	27.5 ab	35.7 bcd	21.1 a
Provado 1.6F	0.250	100.0 e	94.1 def	92.9 c	30.7 ab	31.7 abc	22.7 a
Actara 25 WG	0.063	85.8 b	82.1 c	55.4 b	16.1 a	17.0 ab	21.4 a
Actara 25 WG	0.125	97.3 cde	88.5 de	94.0 c	37.6 b	21.2 ab	22.3 a
Actara 25 WG	0.250	98.0 de	91.4 def	90.7 c	79.4 c	43.0 cd	26.7 ab
V-10066 50WDG	0.250	99.0 de	98.0 f	93.2 c	88.7 c	55.1 d	39.0 b
Dimethoate E267	2.000	90.9 bc	56.6 b	26.4 a	15.9 a	-----	-----
Untreated control	-----	21.2 a	38.6 a	24.2 a	17.4 a	21.4 abc	24.2 a

Evaluation of Systemic Nicotinic Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Ukiah, CA. Seven treatments were replicated four times in a randomized complete block design. Each replicate consisted of an individual tree with buffer trees in each direction. Admire 2F and Platinum 2SC were applied at the popcorn stage, fingerling stage, or both popcorn and fingerling stages. The insecticides were applied on 23 March for the popcorn stage and on 27 April for the fingerling stage. Treatments were applied within a soil trench dug around the base of each tree extending to the drip line. The experimental insecticides were diluted into 25 gal of water and the finished volume was applied to the trench around each tree. After the diluted treatments were absorbed in the ground, an additional 25 gal of clean water was applied around the base of each tree. Control was evaluated by caging 25 laboratory cultured, adult LB on the foliage for approximately 24 hours on 28 April, 31 May and 27 June.

Results and Discussion: The effectiveness of the treatments was evaluated one month after application on 28 April. Admire 0.5 lb. (AI)/ac gave significantly higher LB mortality compared to the untreated control (Table 7). Admire at 0.25 lb. (AI)/ac and Platinum at 0.263 lb. (AI)/ac had a higher percent mortality than the untreated control, but did not differ significantly. The one month delay in evaluation allowed time for the systemic treatments to translocate within the trees. The fingerling timing treatments were not included 28 April evaluation since there was not sufficient time for the materials to translocate up the trees. The corrected mortality (Abbott's formula) showed that Admire at 0.5 lb. (AI)/ac had six times the mortality as Admire at 0.25 lb. (AI)/ac. The second evaluation on 31 May resulted in significantly higher LB mortality in Admire at 0.5 lb. (AI)/ac applied at popcorn stage compared to Admire at 0.5 lb. (AI)/ac applied at fingerling stage. There was no significant difference between Admire at 0.25 lb. (AI)/ac applied at both popcorn and fingerling stages and Admire at 0.5 lb. (AI)/ac applied at either popcorn or fingerling stage. This would indicate that an early application of at least 0.5 lb. (AI)/ac of Admire is required for enough material to reach the foliage and cause significant LB mortality. However, there was no significant difference between any experimental treatment and the untreated control. High mortality was observed in the untreated control when maximum air temperatures exceeded 85°F. Due to the high control morality on the third evaluation of 27 June, no meaningful comparison can be made.

Table 7. Mean Percent Mortality of Lygus Bugs Caged on Trees Treated with Systemic Neonicotinoid Insecticide at Ukiah, CA - 2000

			Mean[a] Percent Mortality					
	Rate		28-Apr		31-May		27-Jun	
Treatment	lb. (AI)/acre	Timing[b]	Actual	Corr.	Actual	Corr.	Actual	Corr.
Admire 2F	0.500	PC	42.1 b	31.7	47.3 b	24.8	19.9 a	0.0
Admire 2F	0.250	PC+F	20.1 ab	5.8	23.6 ab	0.0	25.9 ab	0.0
Admire 2F	0.500	F	----	----	21.8 a	0.0	39.0 b	0.0
Platinum 2SC	0.263	PC	30.3 ab	17.8	25.5 ab	0.0	24.5 ab	0.0
Platinum 2SC	0.263	PC+F	21.2 ab	7.1	32.3 ab	3.4	43.0 b	4.7
Platinum 2SC	0.263	F	----	----	34.8 ab	7.0	26.1 ab	0.0
Untreated	—	—	15.2 a		29.9 ab		40.2 b	

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation.
[b]PC = Popcorn and F = Fingerling

Conclusion: Results suggest that there is systemic activity from both Admire and Platinum in pear trees. However, the amount of Admire or Platinum needed to produce significant LB mortality in large pear trees is excess of 0.5 lb. (AI)/ac and or the timing of application may play a significant role in the efficacy of Admire or Platinum. Early applications appear to provide greater efficacy than later applications. A great deal more research is needed in this area.

Evaluations of Speed Sprayer Applied Neonicotinoid Insecticides for True Bug Control in Pears - 2000

Methods and Materials: A trial was conducted on mature 'Bartlett' pear trees in a commercial orchard in Ukiah, CA adjacent to the Russian River. Foliar sprays were applied on 15 July using a speed sprayer operating at about 1.75 mph with a finished spray volume of 200 gal/acre. Carzol SP and Provado 1.6F were applied to two, unreplicated 1.5 acre plots. Control was evaluated by separately caging 25 laboratory cultured, adult LB, 10 GSB, 25 field captured boxelder bug (BB) nymphs and 10 adult BB on the foliage for 24 hours at 0, 3 and 10 DAT. Four cages were placed in the center of each treatment for each bug species and for each evaluation. At 3 and 10 DAT, D-VAC suction samples were taken from four different sampling areas from each treatment. The four D-VAC sampling areas were: 1) outside the orchard about 10 meters proximate to the Russian River, 2) along the edge between 1 to 3 rows into the orchard, 3) in the middle of each plot and 4) immediately outside the treated plot approximately 5 meters further into the orchard.

Results and Discussion: Provado showed significantly higher LB mortality compared to Carzol and the untreated control at 0 DAT (Table 8). However, there was no significant difference in GSB mortality among the treatments at 0 DAT. Adult and nymph BB mortality was not evaluated at 0 DAT. Provado showed significantly higher LB and GSB mortality compared to

the untreated control at 3 DAT but there was no significant difference between Provado and Carzol. There was no significant difference in adult or nymph BB mortality across the treatments. Carzol provided higher mortality than Provado or the untreated control at 3 DAT. It is possible that BB adults and nymphs were not feeding to any great extent in pears and Carzol, which has more immediate contact active than Provado, caused the mortality through contact instead of injestion. At 10 DAT, there was no significant difference among the treatments in LB, GSB or BB mortality.

In the D-VAC suction samples, Provado appeared to provide some measure of control against both adult and nymph LB (Table 9). No LB adults or nymphs were observed in samples taken from within the Provado treated area while low numbers of LB adults and nymphs were observed from within the untreated control and Carzol treatments. Most BB adults and nymphs were found in samples outside of the treated area, adjacent to the river. No meaningful results can be drawn from this D-VAC work since there were often less true bugs found in the untreated control than in the insecticide treatments.

Table 8. Mean Percent Mortality of Adult and Nymph Lygus Bugs, Stink Bugs and Boxelder Bugs in Ukiah, CA - 2000

		Mean[a] Percent Mortality			
		0 DAT			
Treatment	Rate lb. (AI)/ac	LB	GSB	BB nymph	BB adult
Carzol SP	1.54	36.4 a	20.0 a	---	---
Provado 1.6F	0.25	79.9 b	30.0 a	---	---
Untreated	----	25.9 a	6.7 a	---	---
		3 DAT			
Carzol SP	1.54	28.4 ab	13.3 ab	21.3 a	45.6 a
Provado 1.6F	0.25	60.8 b	53.3 b	1.5 a	20.0 a
Untreated	----	9.2 a	0.0 a	1.7 a	26.7 a
		10 DAT			
Carzol SP	1.54	33.3 a	3.3 a	6.7 a	0.0
Provado 1.6F	0.25	30.8 a	0.0 a	0.0 a	0.1
Untreated	----	34.1 a	3.3 a	0.0 a	0.0

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsine transformation

Table 9. Number of Nymph and Adult Lygus and Boxelder Bugs captured in D-VAC suction samples at 3 DAT and 10 DAT at Ukiah, CA – 2000

	3 DAT

Treatment	Rate lb. (AI)/ac	Lygus Nymph I	II	III	IV	Lygus Adult I	II	III	IV
Carzol SP	1.54	1	0	12	22	1	0	0	7
Provado 1.6F	0.25	0	0	0	0	0	0	0	0
Untreated	----	0	1	1	3	0	0	2	1
		Boxelder Nymph				Boxelder Adult			
		I	II	III	IV	I	II	III	IV
Carzol SP	1.54	1	1	1	1	2	0	0	0
Provado 1.6F	0.25	14	0	2	0	0	0	0	0
Untreated	----	5	0	0	1	0	0	0	0

10 DAT

		Lygus Nymph I	II	III	IV	Lygus Adult I	II	III	IV
Carzol SP	1.54	0	0	2	0	0	0	2	0
Provado 1.6F	0.25	0	0	0	0	0	0	0	0
Untreated	----	0	0	0	0	1	0	0	0
		Boxelder Nymph				Boxelder Adult			
		I	II	III	IV	I	II	III	IV
Carzol SP	1.54	0	0	0	0	3	0	0	1
Provado 1.6F	0.25	14	0	2	0	0	0	0	0
Untreated	----	0	0	0	1	1	0	0	0

I- approximately 10 meters outside the orchard and adjacent the Russian River

II- along the edge of the treated plot

III- within each treated plot

IV- approximately 5 meters outside the treated plot, and further into the orchard

Conclusion: It appears that Provado was more effective in LB and GSB control than Carzol while there is some indication that Carzol may be more effective than Provado for BB control.

Laboratory-Plastic Bag Bioassays of New Insecticides for Lygus and Stink Bug Control - 1999

Methods and Materials: Plastic zip-lock bags (2 to 3 in.) were treated with 10 µl of pesticide diluted in acetone. The pesticide was allowed to dry. Fourteen adult female LB were placed in a plastic zip-lock bag with two small pinto beans. The pinto beans act as spacers. Two bags of each concentration were used for analysis. The bags were held at 73-77°F and mortality was determined after 24 hours. Each potential true bug insecticide was first screened over a wide range on concentrations. The plastic bags were treated with a series of concentrations from 0.1 to 100 times the field rate. If the preliminary LD_{50} was greater than 50 times the field rate, then there were no further laboratory evaluations of the material. If a material showed some promise, then the plastic bags were treated with a series of five to six concentrations of the insecticide. The concentrations of the insecticide were within the expected LD_{10} to LD_{90} range.

Thirteen adult male GSB were placed with their dorsal side on a sticky surface. A dilution series of the potential insecticide was made in acetone. Each adult GSB was treated on the ventral surface of the abdomen with 3µl of pesticide solution using a micro-syringe. The GSB were held at 80°F in a growth chamber and mortality was determined after 24 hours.

Results and Discussion: Eight insecticides were screened for LB LD_{50} values. Two insecticides, Alert SC (chlorfenapyr) and Success 2SC (spinosad), had LD_{50} values greater than 50 times the indicated field rate. Further laboratory evaluations of these two insecticides were suspended. Probit analysis of the dose mortality data from the remaining six insecticides indicated that Dimethoate achieved an acceptable level of control with a LD_{50} below the field rate (Table 10). However, the LD_{50} values of Brigade and Asana were not as encouraging at no less than 4.7 times the field rate. Only Provado had a LD_{50} value similar to Dimethoate. Given that Asana provided good control in our field trials (see Table 10), it appears that the bag bioassay method may not be an appropriate method of estimating field efficacy for LB control. Further research will be conducted to develop an appropriate insecticide screening bioassay method for LB control. These results may be explained based on the temperature in which the LB were held in the bioassays. Field trials indicated that Asana mortality was temperature dependent. The laboratory bioassays were conducted at 77°F or less which might explain the lower than expected mortality. It is also possible that confining the LB in the plastic bag increased the fuming action of Dimethoate and improved its efficacy. The direct topical applications of Dimethoate and Asana on adult GSB produced a LD_{50} at 0.1 times the field rate for Dimethoate and a LD_{50} at 1 time the field rate for Asana (Table 11). Again these results are not what was expected based on field trials. Further research will be conducted next year to improve the bioassay.

Table 10. Laboratory Bioassays for Lygus Bug Control Using Potential Insecticides using 24 hour mortality.

Trade Name	Rate g (AI)/l	Field Rate amount/100 gal.	LC_{50} (95% CL) g (AI)/l	LC_{50} (95% CL) n x field rate
Dimethoate E267	2.4	6.0 pt	1.7 (1.4-1.9)	0.7 (0.6-0.8)
Brigade 10 WP	0.12	1.0 lb.	0.9 (0.7-1.0)	7.1 (5.8-8.1)
Asana 0.66EC	0.09	14.5 oz	0.6 (0.5-0.8)	6.6 (5.3-8.6)
Asana 0.66EC	0.09	14.5 oz	0.4 (0.3-0.5)	4.7 (3.5-5.8)
Pounce 3.2 EC	0.48	16.0 oz	5.2 (3.6-12.8)	10.8 (7.4-26.6)
Pounce 3.2 EC	0.48	16.0 oz	3.3 (2.4-4.8)	7.0 (5.1-9.9)
Pounce 3.2 EC	0.48	16.0 oz	3.5 (1.7-4.6)	7.3 (3.5-9.6)
Provado 1.6F	0.3	20.0 oz	0.4 (0.2-0.5)	1.2 (0.7-1.7)
Actara 25WG	0.09	0.3 lb.	0.6 (0.4-0.8)	6.4 (4.3-8.5)

Table 11. Laboratory Bioassays for Green Stink Bug Control Using Potential Insecticides

Trade Name	Rate g (AI)/l	Field Rate amount/100 gal.	LD_{50} (95% CL) g (AI)/l	LD_{50} (95% CL) n x field rate
Dimethoate E267	2.4	6.0 pt	1.0 (0.1-0.5)	0.1 (0.1-0.2)
Asana 0.66EC	0.09	14.5 oz	0.1 (0.1-0.2)	1.0 (0.7-1.6)

Laboratory - Foliar Bioassays of New Insecticides for Lygus Control - 2000

Methods and Materials: Untreated pear tree shoots were collected from a commercial pear orchard in Fairfield, CA. Limbs were washed with a mild soap solution, rinsed clean, dried and prepared immediately for bioassays, or stored for no more than five days at about 5°C for later use. Prepared shoots were pruned and trimmed to an approximate standard length of about 0.75 meter. Shoots were individually secured into 1000 ml flasks filled with water. Leaves were allowed to dry completely prior to application. Treatments were applied thoroughly over leaf surfaces just to the point of run off using a hand held, mist atomizer. Each insecticide trial was composed of five rates and an untreated control with four replicates per rate of application except the Actara 25WG study, which had three replicates per rate of application. Each replicate consisted of one treated limb caged with 25 mature LB of mixed population (except treatment Actara 25WG which was tested with an all male population) and placed in the greenhouse. Each replicate was monitored at 24 and 48 hours after treatment for LB mortality.

Results and Discussion: These studies were conducted to determine a more accurate method in estimating LB toxicity than the bag method used the previous year. Three insecticides were screened for LB mortality. The LD_{50} values were determined using treated foliage held in the greenhouse. Provado gave excellent LB control and had a LD_{50} value of 0.08 g (AI)/l with LD_{50} value of about 1/4 times the field rate of 20 oz/ac (Table 11). This result is more encouraging and better mimics the field mortality. Thus, the foliage method of determining the LD_{50} values

provides a more realistic mortality values as compared to the bag method of determining the LD_{50} values. However, Actara, had a LD_{50} value of 0.26 g (AI)/l with LD_{50} value about 3 times the field rate of 0.3 lb/ac. This result was discouraging since Actara and Provado had similar field efficacy (see Table 5). Since the sex of the LB tested were mixed and could change from trial to trial, another trial was conducted with Actara using only males. All male population of LB exhibited a relatively poor capacity to control LB with a LD_{50} achieved at nearly three to five times the field rate. Assail was the least effective pesticide tested with LD_{50} value about 9 times the field rate of 0.2 lb/ac. These trials will be repeated next year with only females. However, it appears that foliage bioassay method provides the potential to better mimic the field efficacy.

Table 11. Laboratory Bioassays for True Bug Control Using New Insecticides using 48 hour mortality

Treatment/	Rate	Field Rate	LD_{50} (95% CL)	
Trade Name	g (AI)/l	Amount/100 gal.	g (AI)/l	n x field rate
Provado 1.6F	0.3	20.0oz	0.08 (0.04-0.12)	0.26 (0.13-0.40)
Assail 70WP	0.07	0.2 lb.	0.65 (0.44-0.96)	9.3 (6.3-13.7)
Actara 25WG)	0.09	0.3 lb.	0.26 (0.04-0.5)	2.9 (0.44-5.6)
Actara 25WG[ab]	0.09	0.3 lb.	0.42 (0.17-0.72)	4.7 (1.9-8.0)

[a] CL at 90%

[b] Male Lygus bugs

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FIREBLIGHT CONTROL STRATEGIES USING THE BIOLOGICAL CONTROL *PSEUDOMONAS FLUORESCENS* STRAIN A506 (BLIGHT BAN A506)

(submitted to the Pear Pest Management Alliance)

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ABSTRACT

Fireblight disease, caused by the bacterium *Erwinia amylovora,* has been shown to be partially controlled by the biological control agent *Pseudomonas fluorescens* Strain A506, currently sold as BlightBan A506® by Plant Health Technologies, Inc. Research has also shown that A506 is capable of colonizing blossom tissue at lower than current label rates as long as conditions for colonization are favorable. More recently, it has been observed in small scale trials that colonization of partially opened flower buds (1-5% bloom stage) could be enhanced by combining the A506 with a silicon based surfactant by facilitating penetration deep into bud tissue. A506 could then colonize buds before they became occupied by competing bacteria. This would also theoretically allow the user to apply A506 earlier in the season and eliminate concerns about its compatibility with scab fungicides. Finally, enhanced early colonization could eliminate later sprays.

A demonstration project was conducted in two Bartlett pear orchards in Yuba County to show that 1) A506 could successfully colonize pear trees at half the labeled rate, 2) the number of A506 sprays could be reduced with the use of a silicon-based penetrating surfactant, and 3) A506 could improve fireblight control versus an antibiotics alone program. Treatments were applied by commercial spray rig and consisted of 1) half rate of A506 applied at 20% bloom, full bloom, and rat-tail, with antibiotics, 2) half rate of A506 applied at 1-5% bloom with a silicon based surfactant, then again at rat-tail, with antibiotics, and 3) antibiotics alone. Measurements included monitoring of colonization using a flower rub technique and evaluation of fireblight strikes.

Colonization of A506 was unable to be directly measured because flower rub cultures became rapidly contaminated due to the loss of the antifungal agent cycloheximide for use in isolate petri plates. Fireblight strikes in one orchard, however, were reduced 38% in the A506 plus antibiotic plots and 11% in the A506 plus penetrating surfactant plots. This indirectly indicated successful colonization (very few strikes occurred in any treatment in the second orchard).

Using A506 three times at half rate added $34 per acre to the antibiotic program. The A506 plus penetrating surfactant treatment cost $31.00 but eliminated the full bloom A506 treatment. Program cost must take into consideration resistance to streptomycin, which was present in both orchards.

Plans in 2001 will be to continue to refine the use of A506 as a component of an integrated fireblight program, and to test new biological control methods such as *Bacillus subtillis* (Serenade®, Agra Quest).

INTRODUCTION

Fireblight disease caused by *Erwinia amylovora* is the most severe disease of pear in California. Its incidence limits where pears can be grown, as well as requires great expense and vigilance to control. Control of the disease involves cutting out infected tissue and applying preventative antibiotic or copper treatments when infection is likely. Resistance to one of the two antibiotics, streptomycin, has reduced control options. Copper, while effective, causes fruit russeting, which reduces fresh market value.

Research by U. C. Plant Pathologist Dr. Steve Lindow has led to the commercial availability of a biological control agent, *Pseudomonas fluorescens* Strain A506, marketed as BlightBan A506®, by Plant Health Technologies. A506 works by colonizing flower tissue, thereby preventing colonization of flowers by the fireblight pathogen and other russet-inducing bacteria. Trials over the past decade have shown that fireblight and russet are reduced from 50 to 80% by A506 alone, and that it provides additive control when used in conjunction with streptomycin.

Commercial adoption of A506 has been hindered by several factors: 1) it is suppressed by the antibiotic terramycin and by copper and thus needs to be applied separately (it is totally resistant, however, to streptomycin); 2) there is evidence that it is suppressed by certain scab fungicides, particularly mancozeb (Dithane®) when tank mixed, and 3) it adds expense to an already costly fireblight control program.

Data from the past several years has shown that cost savings can be achieved without sacrificing efficacy by applying lower rates of A506. It was also shown that fewer applications of antibiotics were necessary in an A506 program, thus reducing both chances of resistance build up and program cost.

In 1999, a demonstration trial was established in a Bartlett pear orchard in Wheatland, Yuba County, to show growers that: 1) adequate colonization could be achieved by using a half-rate of A506; 2) the number of antibiotic applications could also be reduced; and 3) A506 would reduce fruit russet if russet conditions prevailed. It was confirmed that A506 is capable of successfully colonizing and spreading through the orchard when applied at half the labeled rate under conditions suitable for colonization (Elkins and Lindow 1999).

In 2000, based on the 1999 results, the half-rate of A506® was applied prior to bloom, then later in the spring to coincide with the onset of the early summer rat-tail bloom period. The pre-bloom timing was combined with a silicon-based surfactant to enhance A506 penetration into the buds, thereby establishing this competitive bacterium in flowers as they emerge. This would then displace other potential bud colonizing bacteria through the entire main bloom and petal fall period, and therefore eliminate additional A506 applications during this period. The later A506 application(s) could then target any potential infections well after the main bloom period ends.

PROCEDURE

Two orchards in the Sacramento Valley were divided into multiple sections. Three treatments were applied: 1) half-rate of A506 (2.7 oz./acre) plus the silicon based surfactant Breakthru® (Plant Health Technologies, Boise, ID), (1 qt./acre) at 1-5% bloom, followed by half-rate of A506 at rat-tail; 2) half-rate of A506 at 20% bloom, full bloom, late rat-tail (grower discretion on exact timing); and 3) normal antibiotic program. Treatments 1 and 2 also received a normal antibiotic program at grower and PCA discretion. Treatments were applied to six replicates at the Wheatland location and three replicates at the Marysville location.

A506 and Breakthru® were applied at 100 gallons per acre. Antibiotics were applied at either 50 or 100 gallons per acre depending on timing. All treatments were applied using a commercial air blast sprayer. The A506 plus Breakthru® treatment was applied March 20-22; full-bloom A506 March 23 (Marysville) and April 3 (Wheatland), and rat-tail application April 19. There were 6 – 8 full antibiotic applications applied between March 23 and April 29 in the normal grower program.

Unopened buds were collected from the Wheatland orchard on March 7 to appraise the existence of any bacteria which could compete with A506. At weekly intervals from March 15 (pre-treatment) through April 27, newly opened blossoms were rubbed onto petri dishes containing agar allowing only growth of strain A506. Each dish was divided into nine sections, and 27 flowers were sampled per plot at each date. Dishes were brought to the laboratory and held for three days to allow the A506 to grow. The colonized sections were then recorded as no growth, some growth, or vigorous growth. A total of six samples were collected. For graphing and analysis, it was planned to convert sample data into ratings using weighted averages (1.0 = no growth to 3.0 = maximum growth), then perform an analysis of variance on ranked transformed data using the Kruskal-Wallis ANOVA for Ranks. This would reveal which effects were significant (i.e. level of A506 and level of antibiotic), as it had in the 1999 trial.

Fireblight strike evaluation: During the treatment period, the growers regularly observed incidence of fireblight in the plot areas. Extensive infection was observed in the Marysville plot in mid-April so fireblight strikes were counted at the Marysville orchard on April 18 and 28. Analysis of variance was performed on the combined number of strikes per tree the two dates. The Wheatland orchard had very few strikes in 2000 so no count was done in that orchard.

Extension of information: Results of the trial were reported at a field meeting held on June 7, 2000 at the Naumes C.E. Sullivan Ranch in Yuba City. This meeting was attended by over 80 apple and pear growers, as well as pest control advisers, media and others (attached agenda).

RESULTS AND DISCUSSION

Pattern of A506 colonization: No significant numbers of competing bacteria were found in pre-treatment bud samples collected March 7. It was discovered soon after sampling began that fungal contamination of agar plates greatly hindered A506 colonization. The selective media used in the past had traditionally been treated with the antifungal agent cycloheximide. This

chemical became unavailable in the 2001 season, rendering the data unreliable and non-analyzable.

Fireblight strike evaluation (Marysville): There were 38% fewer strikes in the A506 plus antibiotic plot than in the plots receiving antibiotics alone. This corroborates previous data showing the additive effect of A506 when applied with antibiotics. Resistance of *Erwina amylovora* to streptomycin at this site was documented during the 2000 season, which may also explain the high incidence of strikes in the antibiotic only plots. The A506 plus Breakthru® plus antibiotic treatment had 11% fewer strikes than where antibiotics were used alone. Data was statistically different only at 0.15%, however, this was encouraging given the large plot size, small number of replications, and variable distribution of fireblight in the field (Table 1).

Table 1: Average number of fireblight strikes - April 18 and 28 combined Marysville, California

Treatment	No. Strikes/tree
A506 plus antibiotics	.55 a
A506 Breakthru® plus antibiotics	.78 a b
Antibiotics only	.88 b

Significant at p = 0.15 (actual p value = 0.12), means separated by Fisher's protected LSD.

Program cost: Applying A506 three times at half-rate added a total of $34.00 per acre to the cost of antibiotic program consisting of six full treatments of streptomycin and terramycin. This must be viewed in the context of the higher number of strikes due to resistance to streptomycin. Previous data has shown that the number of antibiotic treatments can be successfully reduced in an A506 program (Lindow, McGourty, Elkins, 1996). Applying the half rate of A506 with Breakthru® at 1-5% bloom cost $31.00 per acre but eliminated the full bloom A506 application. Actual program cost will depend on number and severity of potential infection periods, streptomycin resistance status, and grower/PCA preference.

CONCLUSIONS AND 2001 PLANS

The demonstration in 2000 failed to directly reconfirm 1999 data showing that *Pseudomonas fluorescens* Strain A506 (Blight Ban A506®) successfully colonized and spread through the orchard when applied at half the labeled rate under conditions suitable for colonization. This was strictly the result of contamination of media plates due to the unavailability of the antifungal chemical cycloheximide. A new anti-fungal compound has been located so that sampling for colonization status can be successfully resumed in 2001.

Fireblight infection in mid-April allowed the number of strikes to be evaluated for each treatment in the Marysville orchard. There were 38% fewer strikes per tree where antibiotics were supplemented with A506 at half the labeled rate. This indirectly indicates successful

colonization by A506 in the orchard. The A506 plus Breakthru® treatment also appears promising, but requires further study.

Plans in 2001 will be to continue to refine the use of A506 as a component of an integrated fireblight program. This is especially important where resistance to streptomycin is present, as it is in the Upper Sacramento Valley. 2001 treatments will also include the newly registered *Bacillus subtillis* biofungicide (Serenade®, Agra Quest) which has shown positive results in recent trials. The newly registered plant growth regulator prohexadione calcium, (Apogee®, BASF) will also be tried to reduce vigorous shoot growth which is associated with late-season infections of vegetative shoots.

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